United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In reply refer to:
1-1-04-F-0115

February 28, 2005

Mr. Gene Fong
Federal Highway Administration
Department of Transportation
650 Capital Mall, Suite 4-100
Sacramento, California 95814

Subject: Biological Opinion and Conference Opinion on the Proposed Pigeon Pass Curve Realignment, Southwest of Livermore, Alameda County, California

Dear Mr. Fong:

This is in response to your February 17, 2004, request for formal consultation with the U.S. Fish and Wildlife Service (Service) on the proposed addition of truck climbing lanes and curve corrections to State Route 84 (Pigeon Pass) in Alameda County, California. Your request was received in this Field Office on February 18, 2004. This document represents the Service's biological opinion on the effects of the action on the endangered San Joaquin kit fox (*Vulpes macrotis mutica*), threatened California red-legged frog (*Rana aurora draytonii*), threatened California tiger salamander (*Ambystoma californiese*), threatened vernal pool fairy shrimp (*Branchinecta lynchi*); and conference opinion on the effects of the action on the proposed critical habitats for the California tiger salamander and the California red-legged frog. This document is issued pursuant to section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

This biological opinion is based on: (1) a letter from the Federal Highway Administration to the Service dated February 17, 2004; (2) *Early Evaluation for the San Joaquin Kit Fox for the Pigeon Pass Curve Correction Project* dated August 22, 2002, that was prepared by the California Department of Transportation; (3) *Biological Assessment Pigeon Pass Curve Realignment, Alameda County State Route 84, southwest of Livermore, Ca 04-Ala-84-33.3-37.0 (20.6-23.0) 04-172400* (Biological Assessment) dated February 2004, that was received by the Service on February 18, 2004; (4) *Large Branchiopod Dry (2002) and Wet (2002-2003) Season Surveys Caltrans SR 84 Curve realignment Project* dated May 2003 that was prepared by URS; (5) a visit to the project site by Chris Nagano of the Service on November 8, 2004; (6) a meeting

November 23, 2004: In response to a request from the Service, the California Department of Transportation sent an e-mail of a photo and plans for the driveway undercrossings of State Route 84.

November 20, 2004: The Service sent the California Department of Transportation an e-mail request for additional information on the culvert undercrossings intended for wildlife at the proposed project.

November 25, 2004: The Service sent the California Department of Transportation an e-mail request for additional information on the lighting that will be used at the proposed project due to the potential effect on the nocturnal activities of the fox, frog, and salamander.

November 28, 2004: The Service sent the California Department of Transportation an e-mail request for additional information on the vernal pools that will be affected by the proposed project.

December 5, 2004: The California Department of Transportation sent an e-mail containing portions of the information that the Service had requested in order to compete the analysis necessary for the formal consultation.

December 8, 2004: Chris Nagano, Cay Goude, Susan Moore, Catrina Martin, and Jim Browning of the Service discussed the project with Jeff Jensen, Chuck Morton, and other members of the California Department of Transportation. The California Department of Transportation stated they would compensate for the adverse effects of the project on the San Joaquin kit fox, California red-legged frog, California tiger salamander, and the vernal pool fairy shrimp.

December 14, 2004: The California Department of Transportation sent an e-mail containing portions of the information that the Service had requested in order to compete the analysis necessary for the formal consultation.

December 15, 2004: Chris Collision of the California Department of Transportation sent an e-mail to Chris Nagano of the Service stating that the Marysville office of the California Department of Transportation, not their Oakland office, was responsible for all negotiations and decisions on the formal consultation on the Pigeon Pass Project.

December 20, 2004: The Service sent an e-mail to the California Department of Transportation requesting information on night lighting, vernal pools, and the California red-legged frog at the project site.

January 7, 2005: Chris Nagano, Wayne White, Susan Moore, and Cay Goude discussed the proposed project with Susan Chang and Jeff Jensen of the California Department of Transportation.

February 15, 2005: The Service received a letter from Susan Chang of the California Department of Transportation regarding the habitat for the California tiger salamander, California red-legged frog, San Joaquin kit fox, and the vernal pool fairy shrimp that will be protected as compensation for adverse effects resulting from the proposed project.

3. The contractor shall be required to submit a Storm Water Pollution Prevention Plan as required by the National Pollutant Discharge Elimination System permit.

4. Additional water quality protection measures required by other permits such as the California Department of Fish and Game's Lake and Streambed Alteration Agreement will be implemented.

5. Twelve drainage culverts and two driveway under crossings will be installed throughout the project area, which can provide a method of crossing under the new highway.

6. A qualified biologist shall be on-site or on-call during all activities that could result in the take of listed species. The qualification of the biologist(s) shall be presented to the Service for review and approval at least 60 calendar days prior to any groundbreaking at the project site. The biologist(s) shall be given the authority to stop any work that may result in the take of listed species. If the biologist(s) exercises this authority, the Service and the California Department of Fish and Game shall be notified by telephone and electronic mail within one (1) working day. The Service contact is the Deputy Assistant Field Supervisor, Endangered Species Program at the Sacramento Fish and Wildlife Office at telephone 916/414-6600.

7. Environmentally sensitive areas (ESAs) will be established, and marked in the field with standard orange mesh ESA fencing, around known avoidable vernal pools, amphibian breeding and aestivation areas, and any active, or potentially active, kit fox dens. Under the direction of the California Department of Transportation Resident Engineer, with the aid of the Service approved biologist, the ESA fence will be erected around the ESAs to prevent areas from being disturbed during construction.

8. The limits of the construction area will be flagged, if not already marked by right of way, or other, fencing, and all activity will be confined within the marked area. All access to and from the project area will be clearly marked in the field with appropriate flagging and signs. Prior to commencing construction activities, the contractor will determine construction vehicle parking and all access.

9. Project-related vehicles shall observe a 20-mile per hour speed limit in all project areas, except on county roads and State and Federal highways; this is particularly important at night when California red-legged frogs, California tiger salamanders, and kit foxes are most active.

10. To the extent possible, nighttime construction should be minimized. Construction crews will be informed during the education program meeting that, to the extent possible, travel within the marked project site will be restricted to established roadbeds. Established roadbeds include all pre-existing and project-constructed unimproved, as well as, improved roads.

during construction may be destroyed by excavation, with the exception of natal/pupping dens.

3. Following preconstruction den searches and excavations of unavoidable dens but before construction begins, the Resident Engineer, with the assistance of the Service approved biologist, will establish Environmentally Sensitive Areas around those kit fox dens which are determined by the California Department of Transportation to be reasonably avoidable. ESA radii will be: potential den = (50 feet); known den = (100 feet); natal or pupping den = to be determined on a case-by-case basis in coordination with the Service and the California Department of Fish and Game.

4. To prevent inadvertent entrapment of kit foxes or other animals during the construction phase of a project, all excavated, steep-walled holes or trenches more than (2 feet) deep should be covered at the close of each working day by plywood or similar materials, or provided with one or more escape ramps constructed of earth fill or wooden planks. Before such holes or trenches are filled, they should be thoroughly inspected for trapped animals.

5. Kit foxes are attracted to den-like structures such as pipes and may enter stored pipe becoming trapped or injured. All construction pipes, culverts, or similar structures with a diameter of (4-inches) or greater that are stored at a construction site for one or more overnight periods should be thoroughly inspected for kit foxes prior to commencing construction activities for the day, or, at the latest, before the pipe is subsequently buried, capped, or otherwise used or moved in any way. If a kit fox is discovered inside a pipe, that section of pipe should not be moved until the Service has been consulted. If necessary, and under the direct supervision of the Service approved biological monitor, the pipe may be moved once to remove it from the path of construction activity, until the fox has escaped.

6. All food-related trash items such as wrappers, cans, bottles, and food scraps should be disposed of in closed containers and removed at least once a week from a construction or project site.

7. California Department of Transportation employees, contractors, and contractors' employees shall not have firearms on the project site. This shall not apply to authorized security personnel, or local, State, or Federal law enforcement officials.

8. The California Department of Transportation Resident Engineer is the point of contact in the event that any employee or contractor might inadvertently kill or injure a kit fox or who finds a dead, injured or entrapped individual. The Resident Engineer will be identified in the employee education program. The Resident Engineer's name and phone number will be provided to the Service.

Avoidance and Protection Measures - Vernal Pool Fairy Shrimp

1. The California Department of Transportation will purchase 2.06 acres or 2.06 acre credits of habitat for the vernal pool fairy shrimp. The California Department of Transportation will ensure the Service approves of the means of compensation that will be used for this listed crustacean prior to construction.

## STATUS OF SPECIES/ENVIRONMENTAL BASELINE

### San Joaquin Kit Fox

The San Joaquin kit fox was listed as an endangered species on March 11, 1967 (U.S. Fish and Wildlife Service 1967) and it was listed by the State of California as a threatened species on June 27, 1971. The *Recovery Plan for Upland Species of the San Joaquin Valley, California* includes this listed canine (U.S. Fish and Wildlife Service 1998).

In the San Joaquin Valley before 1930, the range of the San Joaquin kit fox extended from southern Kern County north to Tracy in San Joaquin County, on the west side, and near La Grange in Stanislaus County, on the east side (Grinnell *et al.* 1937; U.S. Fish and Wildlife Service 1998). Historically, this species occurred in several San Joaquin Valley native plant communities. In the southernmost portion of the range, these communities included Valley Sink Scrub, Valley Saltbush Scrub, Upper Sonoran Subshrub Scrub, and Annual Grassland. San Joaquin kit foxes also exhibit a capacity to utilize habitats that have been altered by man. The animals are present in many oil fields, grazed pasturelands, and "wind farms" (Cypher 2000). Kit foxes can inhabit the margins and fallow lands near irrigated row crops, orchards, and vineyards, and may forage occasionally in these agricultural areas (U.S. Fish and Wildlife Service 1998). There are a limited number of observations of San Joaquin kit foxes foraging in trees in urban areas (Murdoch *et al.* 2005). The San Joaquin kit fox seems to prefer more gentle terrain and decreases in abundance as terrain ruggedness increases (Grinnell *et al.* 1937; Morrell 1972; Warrick and Cypher 1998).

Adult San Joaquin kit foxes are usually solitary during late summer and fall. In September and October, adult females begin to excavate and enlarge natal dens (Morrell 1972), and adult males join the females in October or November (Morrell 1972). Typically, pups are born between February and late March following a gestation period of 49 to 55 days (Egoscue 1962; Morrell 1972; Spiegel and Tom 1996; U.S. Fish and Wildlife Service 1998). Mean litter sizes reported for San Joaquin kit foxes include 2.0 on the Carrizo Plain (White and Ralls 1993), 3.0 at Camp Roberts (Spencer *et al.* 1992), 3.7 in the Lokern area (Spiegel and Tom 1996), and 3.8 at the Naval Petroleum Reserve (Cypher *et al.* 2000). Pups appear above ground at about age 3-4 weeks, and are weaned at age 6-8 weeks. Reproductive rates, the proportion of females bearing young, of adult San Joaquin kit foxes vary annually with environmental conditions, particularly food availability. Annual rates range from 0-100%, and reported mean rates include 61% at the Naval Petroleum Reserve (Cypher *et al.* 2000), 64% in the Lokern area (Spiegel and Tom 1996), more recent study in the Coast Range, 79 percent of active kit fox dens lacked evidence of recent use other than signs of recent excavation (Jones and Stokes Associates 1997).

A San Joaquin kit fox can use more than 100 dens throughout its home range, although on average, an animal will use approximately 12 dens a year for shelter and escape cover (Cypher *et al.* 2001). Kit foxes typically use individual dens for only brief periods, often for only one day before moving to another den (Ralls *et al.* 1990). Possible reasons for changing dens include infestation by ectoparasites, local depletion of prey, or avoidance of coyotes (*Canis latrans*). Kit foxes tend to use dens that are located in the same general area, and clusters of dens can be surrounded by hundreds of hectares of similar habitat devoid of other dens (Egoscue 1962). In the southern San Joaquin Valley, kit foxes were found to use up to 39 dens within a denning range of 320 to 482 acres (Morrell 1972). An average den density of one den per 69 to 92 acres was reported by O'Farrell (1984) in the southern San Joaquin Valley.

Dens are used by San Joaquin kit foxes for temperature regulation, shelter from adverse environmental conditions, and escape from predators. Kit foxes excavate their own dens, use those constructed by other animals, and use human-made structures (culverts, abandoned pipelines, and banks in sumps or roadbeds). Kit foxes often change dens and may use many dens throughout the year; however, evidence that a den is being used by kit foxes may be absent. San Joaquin kit foxes have multiple dens within their home range and individual animals have been reported to use up to 70 different dens (Hall 1983). At the Naval Petroleum Reserve, individual kit foxes used an average of 11.8 dens per year (Koopman *et al.* 1998). Den switching by the San Joaquin kit fox may be a function of predator avoidance, local food availability, or external parasite infestations (e.g., fleas) in dens (Egoscue 1956).

The diet of the San Joaquin kit fox varies geographically, seasonally, and annually, based on temporal and spatial variation in abundance of potential prey. Known prey species of the kit fox include white-footed mice (*Peromyscus* spp.), insects, California ground squirrels, kangaroo rats (*Dipodomys* spp.), San Joaquin antelope squirrels (*Ammospermophilus nelsoni*), black-tailed hares (*Lepus californicus*), and chukar (*Alectoris chukar*) (Jensen 1972; Archon 1992). Kit foxes also prey on desert cottontails (*Sylvilagus audubonii)*, ground-nesting birds, and pocket mice (*Perognathus* spp.).

The diets and habitats selected by coyotes and San Joaquin kit foxes living in the same areas are often quite similar. Hence, the potential for resource competition between these species may be quite high when prey resources are scarce such as during droughts, which are quite common in semi-arid, central California. Competition for resources between coyotes and kit foxes may result in kit fox mortalities. Coyote-related injuries accounted for 50-87 per cent of the mortalities of radio collared kit foxes at Camp Roberts, the Carrizo Plain Natural Area, the Lokern Natural Area, and the Naval Petroleum Reserve (Cypher and Scrivner 1992; Standley *et al.* 1992).

San Joaquin kit foxes are primarily nocturnal, although individuals are occasionally observed resting or playing (mostly pups) near their dens during the day (Grinnell *et al.* 1937). Kit foxes

Loss of Habitat

Less than 20 percent of the habitat within the historical range of the kit fox remained when the animal was listed as federally-endangered in 1967, and there has been a substantial net loss of habitat since that time. Historically, San Joaquin kit foxes occurred throughout California's Central Valley and adjacent foothills. Extensive land conversions in the Central Valley began as early as the mid-1800s with the Arkansas Reclamation Act. By the 1930's, the range of the kit fox had been reduced to the southern and western parts of the San Joaquin Valley (Grinnell *et al.* 1937). The primary factor contributing to this restricted distribution was the conversion of native habitat to irrigated cropland, industrial uses (e.g., hydrocarbon extraction), and urbanization (Laughrin 1970; Jensen 1972; Morrell 1972, 1975). Approximately one-half of the natural communities in the San Joaquin Valley were tilled or developed by 1958 (U.S. Fish and Wildlife Service 1980).

This rate of loss accelerated following the completion of the Central Valley Project and the State Water Project, which diverted and imported new water supplies for irrigated agriculture (U.S. Fish and Wildlife Service 1995a). Approximately 1.97 million acres of habitat, or about 66,000 acres per year, were converted in the San Joaquin region between 1950 and 1980 (California Department of Forestry and Fire Protection 1988). The counties specifically noted as having the highest wildland conversion rates included Kern, Tulare, Kings and Fresno, all of which are occupied by kit foxes. From 1959 to 1969 alone, an estimated 34 percent of natural lands were lost within the then-known kit fox range (Laughrin 1970).

By 1979, only approximately 370,000 acres out of a total of approximately 8.5 million acres on the San Joaquin Valley floor remained as non-developed land (Williams 1985; U.S. Fish and Wildlife Service 1980). Data from the California Department of Fish and Game (1985) and Service file information indicate that between 1977 and 1988, essential habitat for the blunt-nosed leopard lizard, a species that occupies habitat that is also suitable for kit foxes, declined by about 80 percent – from 311,680 acres to 63,060 acres, an average of about 22,000 acres per year (Biological Opinion for the Interim Water Contract Renewal, Service file 1-1-00-F-0056, February 29, 2000). Virtually all of the documented loss of essential habitat was the result of conversion to irrigated agriculture.

During 1990 to 1996, a gross total of approximately 71,500 acres of habitat were converted to farmland in 30 counties (total area 23.1 million acres) within the Conservation Program Focus area of the Central Valley Project. This figure includes 42,520 acres of grazing land and 28,854 acres of "other" land, which is predominantly comprised of native habitat. During this same time period, approximately 101,700 acres were converted to urban land use within the Conservation Program Focus area (California Department of Conservation 1994, 1996, 1998). This figure includes 49,705 acres of farmland, 20,476 acres of grazing land, and 31,366 acres of "other" land, which is predominantly comprised of native habitat. Because these assessments included a substantial portion of the Central Valley and adjacent foothills, they provide the best scientific and commercial information currently available regarding the patterns and trends of land conversion within the kit fox's geographic range. More than one million acres of suitable habitat species adapted to early successional stages and disturbed areas (e.g., California ground squirrels)(Spiegel 1996). Because more than 70 percent of the diets of kit foxes usually consist of abundant rabbits (*Lepus*, *Sylvilagus*) and rodents (e. g., *Dipodomys* spp.), and kit foxes often continue to feed on their staple prey during ephemeral periods of prey scarcity, such changes in the availability and selection of foraging sites by kit foxes could influence their reproductive rates, which are strongly influenced by food supply and decrease during periods of prey scarcity (White and Garrott 1997, 1999).

Extensive habitat destruction and fragmentation have contributed to smaller, more-isolated populations of kit foxes. Small populations have a higher probability of extinction than larger populations because their low abundance renders them susceptible to stochastic (i.e., random) events such as high variability in age and sex ratios, and catastrophes such as floods, droughts, or disease epidemics (Lande 1988; Frankham and Ralls 1998; Saccheri *et al.* 1998). Similarly, isolated populations are more susceptible to extirpation by accidental or natural catastrophes because their recolonization has been hampered. These chance events can adversely affect small, isolated populations with devastating results. Extirpation can even occur when the members of a small population are healthy, because whether the population increases or decreases in size is less dependent on the age-specific probabilities of survival and reproduction than on raw chance (sampling probabilities). Owing to the probabilistic nature of extinction, many small populations will eventually lose out and go extinct when faced with these stochastic risks (Caughley and Gunn 1995).

Oil fields in the southern half of the San Joaquin Valley also continue to be an area of expansion and development activity. This expansion is reasonably certain to increase in the near future owing to market-driven increases in the price of oil. The cumulative and long-term effects of oil extraction activities on kit fox populations are not fully known, but recent studies indicate that moderate- to high-density oil fields may contribute to a decrease in carrying capacity for kit foxes owing to habitat loss or changes in habitat characteristics (Spiegel 1996; Warrick and Cypher 1998). There are no limiting factors or regulations that are likely to retard the development of additional oil fields. Hence, it is reasonably certain that development will continue to destroy and fragment kit fox habitat into the foreseeable future.

Competitive Interactions with Other Canids

Several species prey upon San Joaquin kit foxes. Predators (such as coyotes, bobcats, non-native red foxes, badgers, and golden eagles (*Aquila chrysaetos*) will kill kit foxes. Badgers, coyotes, and red foxes also may compete for den sites (U.S. Fish and Wildlife Service 1998). The diets and habitats selected by coyotes and kit foxes living in the same areas are often quite similar (Cypher and Spencer 1998). Hence, the potential for resource competition between these species may be quite high when prey resources are scarce such as during droughts, which are quite common in semi-arid, central California. Land conversions and associated human activities have led to changes in the distribution and abundance of coyotes, which compete with kit foxes for resources.

Disease

Wildlife diseases do not appear to be a primary mortality factor that consistently limits kit fox populations throughout their range (McCue and O'Farrell 1988; Standley and McCue 1992). However, central California has a high incidence of wildlife rabies cases (Schultz and Barrett 1991), and high seroprevalences of canine distemper virus and canine parvovirus indicate that kit fox populations have been exposed to these diseases (McCue and O'Farrell 1988; Standley and McCue 1992). Hence, disease outbreaks could potentially cause substantial mortality or contribute to reduced fertility in seropositive females, as was noted in the closely-related swift fox (*Vulpes velox*).

For example, there are some indications that rabies virus may have contributed to a catastrophic decrease in kit fox abundance at Camp Roberts, San Luis Obispo County, California, during the early 1990's. San Luis Obispo County had the highest incidence of wildlife rabies cases in California during 1989 to 1991, and striped skunks (*Mephitis mephitis*) were the primary vector (Barrett 1990; Schultz and Barrett 1991; Reilly and Mangiamele 1992). A rabid skunk was trapped at Camp Roberts during 1989 and two foxes were found dead due to rabies in 1990 (Standley *et al.* 1992). Captures of kit foxes during annual live trapping sessions at Camp Roberts decreased from 103 to 20 individuals during 1988 to 1991. Captures of kit foxes were positively correlated with captures of skunks during 1988 to 1997; suggesting that some factor(s) such as rabies virus was contributing to concurrent decreases in the abundances of these species. Also, captures of kit foxes at Camp Roberts were negatively correlated with the proportion of skunks that were rabid when trapped by County Public Health Department personnel two years previously. These data suggest that a rabies outbreak may have occurred in the skunk population and spread into the fox population. A similar time lag in disease transmission and subsequent population reductions was observed in Ontario, Canada, although in this instance the transmission was from red foxes to striped skunks (Macdonald and Voigt 1985).

Pesticides and Rodenticides

Pesticides and rodenticides pose a threat to kit foxes through direct or secondary poisoning. Kit foxes may be killed if they ingest rodenticide in a bait application, or if they eat a rodent that has consumed the bait. Even sublethal doses of rodenticides may lead to the death of these animals by impairing their ability to escape predators or find food. Pesticides and rodenticides may also indirectly affect the survival of kit foxes by reducing the abundances of their staple prey species.

For example, the California ground squirrel, which is the staple prey of kit foxes in the northern portion of their range, was thought to have been eliminated from Contra Costa County in 1975, after extensive rodent eradication programs. Field observations indicated that the long-term use of ground squirrel poisons in this county severely reduced kit fox abundance through secondary poisoning and the suppression of populations of its staple prey (Orloff *et al.* 1986).
Kit foxes occupying habitats adjacent to agricultural lands are also likely to come into contact with insecticides applied to crops owing to runoff or aerial drift. Kit foxes could be affected through direct contact with sprays and treated soils, or through consumption of contaminated

Opinion for the Interim Water Contract Renewal, Service file 1-1-00-F-0056, February 29, 2000).

A September 22, 1993, biological opinion issued by the U.S. Fish and Wildlife Service to the Environmental Protection Agency (EPA) regarding the regulation of pesticide use (31 registered chemicals) through administration of the Federal Insecticide, Fungicide, and Rodenticide Act found that use of the following chemicals would likely jeopardize the continued existence of the kit fox: (1) aluminum and magnesium phosphide fumigants; (2) chlorophacinone anticoagulants; (3) diphacinone anticoagulants; (4) pival anticoagulants; (5) potassium nitrate and sodium nitrate gas cartridges; and (6) sodium cyanide capsules (U.S. Fish and Wildlife Service 1993). Reasonable and prudent alternatives to avoid jeopardy included restricting the use of aluminum/magnesium phosphide, potassium/sodium nitrate within the geographic range of the kit fox to qualified individuals, and prohibiting the use of chlorophacinone, diphacinone, pival, and sodium cyanide within the geographic range of the kit fox, with certain exceptions (e.g., agricultural areas that are greater than 1 mile from any kit fox habitat)(U.S. Fish and Wildlife Service 1999).

Endangered Species Act Section 9 Violations and Noncompliance with the Terms and Conditions of Existing Biological Opinions

The intentional or unintentional destruction of habitat occupied by the San Joaquin kit fox is an issue of serious concern. Section 9 of the Act prohibits the "take" (e.g., harm, harass, pursue, injure, kill) of federally-listed wildlife species. "Harm" is further defined to include habitat modification or degradation that kills or injures wildlife by impairing essential behavioral patterns including breeding, feeding, or sheltering. Congress established two provisions (under sections 7 and 10 of the Act) that allow for the incidental take of listed species of wildlife by Federal agencies, non-Federal government agencies, and private parties. Incidental take is defined as take that is "...incidental to, and not the purpose of, the carrying out of an otherwise lawful activity." If no permit is obtained for the incidental take of listed species, the individuals or entities responsible for these actions could be liable under section 9 of the Act if any unauthorized take occurs. There are numerous examples of section 9 violations and noncompliance with the terms and conditions of existing biological opinions.

Risk of Chance Extinction Owing to Small Population Size, Isolation, and High Natural Fluctuations in Abundance

Historically, kit foxes may have existed in a metapopulation structure of core and satellite populations, some of which periodically experienced local extinctions and recolonization (U.S. Fish and Wildlife Service 1998). Today's populations exist in an environment drastically different from the historic one, however, and extensive habitat fragmentation will result in geographic isolation, smaller population sizes, and reduced genetic exchange among populations; all of which increase the vulnerability of kit fox populations to extirpation. Populations of kit foxes are extremely susceptible to the risks associated with small population size and isolation because they are characterized by marked instability in population density. For example, the

Preliminary estimates of expected heterozygosity from foxes in this area indicate that this population already may have reduced genetic variation. Other populations that may be showing the initial signs of genetic isolation are the Lost Hills area and populations in the Salinas-Pajaro River watershed (i.e., Camp Roberts and Fort Hunter Liggett). Preliminary estimates of the mean number of alleles per locus from foxes in these populations indicate that allelic diversity is lower than expected. Although these results may, in part, be due to the small number of foxes sampled in these areas, they may also be indicative of an increase in the amount of inbreeding due to population subdivision (M. Schwartz, pers. Comm.. to P. J. White, March 23, 2000). Further sampling and analyses are necessary to adequately assess the effects of these potential genetic bottlenecks.

Arid systems are characterized by unpredictable fluctuations in precipitation, which lead to high frequency, high amplitude fluctuations in the abundance of mammalian prey for kit foxes (Goldingay *et al.* 1997; White and Garrott 1999). Because the reproductive and neonatal survival rates of kit foxes are strongly-depressed at low prey densities (White and Ralls 1993; White and Garrott 1997, 1999), periods of prey scarcity owing to drought or excessive rain events can contribute to population crashes and marked instability in the abundance and distribution of kit foxes (White and Garrott 1999). In other words, unpredictable, short-term fluctuations in precipitation and, in turn, prey abundance can generate frequent, rapid decreases in kit fox density that increase the extinction risk for small, isolated populations.

The primary goal of the recovery strategy for kit foxes identified in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (U.S. Fish and Wildlife 1998) is to establish a complex of interconnected core and satellite populations throughout the species' range. The long-term viability of each of these core and satellite populations depends partly upon periodic dispersal and genetic flow between them. Therefore, kit fox movement corridors between these populations must be preserved and maintained. In the northern range, from the Ciervo Panoche in Fresno County northward, kit fox populations are small and isolated, and have exhibited significant decline. The core populations are the Ciervo Panoche area, the Carrizo Plain area, and the western Kern County population. Satellite populations are found in the urban Bakersfield area, Porterville/Lake Success area, Creighton Ranch/Pixley Wildlife Refuge, Allensworth Ecological Reserve, Semitropic/Kern National Wildlife Refuge (NWR), Antelope Plain, eastern Kern grasslands, Pleasant Valley, western Madera County, Santa Nella, Kesterson NWR, and Contra Costa County. Major corridors connecting these population areas are on the east and west side of the San Joaquin Valley including the Millerton Lake area of Fresno Countyty, around the bottom of the Valley, and cross-valley corridors in Kern, Fresno, and Merced counties.

From 1991 to 2000, the Service authorized incidental take for thirteen projects in Alameda, Contra Costa, San Joaquin, and Stanislaus Counties that have resulted in the loss or degradation of approximately 2,644 acres of San Joaquin kit fox habitat (U.S. Fish and Wildlife Service 2001). Compensation measures for these projects protected or will protect 3,016 acres of kit fox habitat within this area. However, much of these conservation measures are in the form of conservation easements, and for the most part, the lands are not actively managed for kit fox.

at the entrances of dens; they also reported other prey species of the San Joaquin kit fox in the form of the western fence lizards (*Sceloporus occidentalis*), black-tailed jack rabbits, and snakes. Several squirrel dens appeared to be enlarged by another animal (California Department of Transportation 2004). The San Joaquin kit fox has been documented to enlarge and utilize ground squirrel burrows. In addition, individuals of this species have been recorded to move as far as 9 miles or more in a single night (U.S. Fish and Wildlife Service 1998). The closest kit fox sighting to the proposed project is approximately 5 miles from the project site. There are no obvious natural barriers that would prevent kit fox movement within a 10-mile radius. Therefore, the Service believes that the San Joaquin kit fox is reasonably certain to occur within the action area because of the biology and ecology of the animal, the presence of suitable habitat in and adjacent to the project, as well as the nearby observations of this listed species.

**California Tiger Salamander**

The final rule listing the California tiger salamander as a threatened species was published on August 4, 2004 (U.S. Fish and Wildlife 2004).

The California tiger salamander is a large, stocky, terrestrial salamander with a broad, rounded snout. Adults may reach a total length of 8.2 inches Petranka 1998; Stebbins 2003). California tiger salamanders exhibit sexual dimorphism; males tend to be larger than females. The coloration of the California tiger salamander is white or yellowish markings against black. As adults, California tiger salamanders tend to have the creamy yellow to white spotting on the sides with much less on the dorsal surface of the animal, whereas other tiger salamander species have brighter yellow spotting that is heaviest on the top of the animals.

Historically, the California tiger salamander inhabited low elevation grassland and oak savanna plant communities of the Central Valley, and adjacent foothills, and the inner coast ranges in California (Jennings and Hayes 1994; Storer 1925; Shaffer *et al.* 1993). The species occurs from near sea level up to approximately 3900 feet in the coast ranges and up to about 1600 feet in the Sierra Nevada foothills (Shaffer *et al.* 2004). Along the coast ranges, the species occurred from the Santa Rosa area of Sonoma County south to the vicinity of Buellton in Santa Barbara County. In the Central Valley and surrounding foothills, the species occurred from northern Yolo County southward to northwestern Kern County and northern Tulare County.

The California tiger salamander has an obligate biphasic life cycle (Shaffer *et al.* 2004). Although the larvae salamanders develop in the vernal pools and ponds in which they were born, they are otherwise terrestrial salamanders that spend most of their postmetamorphic lives in widely dispersed underground retreats (Shaffer *et al.* 2004; Trenham *et a*l. 2001). Subadult and adult California tiger salamanders spend the dry summer and fall months of the year in the burrows of small mammals, such as California ground squirrels and Botta's pocket gopher (*Thomomys bottae*) (Storer 1925; Loredo and Van Vuren 1996; Petranka 1998; Trenham 1998a). Camel crickets and other invertebrates within these burrows likely are prey for California tiger salamanders, as well as protection from the sun and wind associated with the dry California climate that can cause dessication (drying out) of amphibian skin. Although California tiger salamanders are members of a family known as "burrowing salamanders," California tiger grow to a critical minimum body size before they can metamorphose (change into a different physical form) to the terrestrial stage (Wilbur and Collins 1973). Individuals collected near Stockton in the Central Valley during April varied from 1.88 to 2.32 inches in length (Storer 1925). Feaver (1971) found that larvae metamorphosed and left the breeding pools 60 to 94 days after the eggs had been laid, with larvae developing faster in smaller, more rapidly drying pools. The longer the ponding duration, the larger the larvae and metamorphosed juveniles are able to grow, and the more likely they are to survive and reproduce (Pechmann *et al.* 1989; Semlitsch et al. 1988; Morey 1998; Trenham 1998b). The larvae will perish if a site dries before metamorphosis is complete (P. Anderson 1968; Feaver 1971). Pechmann *et al.* (1988) found a strong positive correlation with ponding duration and total number of metamorphosing juveniles in five salamander species. In Madera County, Feaver (1971) found that only 11 of 30 pools sampled supported larval California tiger salamanders, and 5 of these dried before metamorphosis could occur. Therefore, out of the original 30 pools, only six (20 percent) provided suitable conditions for successful reproduction that year. Size at metamorphosis is positively correlated with stored body fat and survival of juvenile amphibians, and negatively correlated with age at first reproduction (Semlitsch *et al.* 1988; Scott 1994; Morey 1998). In the late spring or early summer, before the ponds dry completely, metamorphosed juveniles leave them and enter upland habitat. This emigration occurs in both wet and dry conditions (Loredo and Van Vuren 1996; Loredo *et al.* 1996). Unlike during their winter migration, the wet conditions that California tiger salamanders prefer do not generally occur during the months when their breeding ponds begin to dry. As a result, juveniles may be forced to leave their ponds on rainless nights. Under these conditions, they may move only short distances to find temporary upland sites for the dry summer months, waiting until the next winter's rains to move further into suitable upland refugia. Once juvenile California tiger salamanders leave their birth ponds for upland refugia, they typically do not return to ponds to breed for an average of 4 to 5 years. However, they remain active in the uplands, coming to the surface during rainfall events to disperse or forage (Trenham and Shaffer, unpublished manuscript).

Lifetime reproductive success for California and other tiger salamanders is low. Trenham *et al.* (2000) found the average female bred 1.4 times and produced 8.5 young that survived to metamorphosis per reproductive effort. This resulted in roughly 11 metamorphic offspring over the lifetime of a female. Two reasons for the low reproductive success are the preliminary data suggest that most individuals of the California tiger salamanders require two years to become sexually mature, but some individuals may be slower to mature (Shaffer *et al.* 1993); and some animals do not breed until they are four to six years old. While individuals may survive for more than ten years, many breed only once, and in some populations, less than 5 percent of marked juveniles survive to become breeding adults (Trenham 1998b). With such low recruitment, isolated populations are susceptible to unusual, randomly occurring natural events as well as from human caused factors that reduce breeding success and individual survival. Factors that repeatedly lower breeding success in isolated pools can quickly extirpate a population.

Dispersal and migration movements made by California tiger salamanders can be grouped into two main categories: (1) breeding migration; and (2) interpond dispersal. Breeding migration is the movement of salamanders to and from a pond from the surrounding upland habitat. After metamorphosis, juveniles move away from breeding ponds into the surrounding uplands, where landscape. Trenham (2001) found that radio-tracked adults favored grasslands with scattered large oaks, over more densely wooded areas. A drift-fence survey at a Santa Barbara County pond that is bordered by a strawberry field found that many emigrating juveniles moved towards the strawberry field; however, no adults were captured entering the pond from this direction. Most of the California tiger salamanders entered the pond from extensive, overgrazed grassy flats rather than sandhill or eucalyptus habitats in other quadrants (Steve Sykes, University of California at Santa Barbara, unpublished data 2003). Based on radio-tracked adults, there is no indication that certain habitat types are favored as corridors for terrestrial movements (Trenham 2001). In addition, at two ponds completely encircled by drift fences and pitfall traps, captures of arriving adults and dispersing new metamorphs were distributed roughly evenly around the ponds. Thus, it appears that dispersal into the terrestrial habitat occurs randomly with respect to direction and habitat types.

Several species prey have either been documented or likely prey upon the California tiger salamander including coyotes (*Canis latrans*), raccoons (*Procyon lotor*), opossums (*Didelphis virginiana*), egrets (*Egretta* species), great blue herons (*Ardea herodias*), crows (*Corvus brachyrhynchos*), ravens (*Corvus corax*), bullfrogs (*Rana catesbeiana*), mosquito fish (*Gambusia affinis*), and crayfish (*Procrambus* species). Domestic dogs (*Canis familiaris*) have been observed eating California tiger salamanders at Lake Lagunitas at Stanford University (Sean Barry, ENTRIX, pers. comm. to C. Nagano July 2004).

The California tiger salamander is imperiled throughout its range by a variety of human activities (U.S. Fish and Wildlife Service 2004). Current factors associated with declining populations of the salamander include continued degradation and loss of habitat due to agriculture and urbanization, hybridization with non-native eastern tiger salamanders (*Ambystoma tigrinum*)(Fitzpatrick and Shaffer 2004; Riley *et al.* 2003), and introduced predators. Fragmentation of existing habitat and the continued colonization of existing habitat by non-native tiger salamanders (*Ambystoma tigrinum* and other species) may represent the most significant current threats to California tiger salamanders, although populations are likely threatened by more than one factor. Isolation and fragmentation of habitats within many watersheds have precluded dispersal between sub-populations and jeopardized the viability of metapopulations (broadly defined as multiple subpopulations that occasionally exchange individuals through dispersal, and are capable of colonizing or "rescuing" extinct habitat patches). Other threats are predation and competition from introduced exotic species; possible commercial overutilization; disease; various chemical contaminants; road-crossing mortality; and certain unrestrictive mosquito and rodent control operations. The various primary and secondary threats are not currently being offset by existing Federal, State, or local regulatory mechanisms. The California tiger salamander also is vulnerable to chance environmental or demographic events, to which small populations are particularly vulnerable.

Thirty-one percent (221 of 711 records and occurrences) of all Central California tiger salamander records and occurrences are in Alameda, Santa Clara, San Benito (excluding the extreme western end of the County), southwestern San Joaquin, western Stanislaus, western Merced, and southeastern San Mateo counties, most of them are in eastern Alameda and Santa Clara counties (Buckingham in litt. 2003; California Department of Fish and Game 2003; U.S.

County totaling 310 acres, two in San Joaquin County totaling 12,427 acres and one in Santa Clara County totaling 19 acres.

Larvae California tiger salamander were observed in the large pool designated as Site 1 in the fairy shrimp survey (URS 2003), and there are numerous recent sightings in this area recorded in the California Natural Diversity Data Base (California Department of Fish and Game 2004). Suitable salamander breeding habitat also exists in a 60-acre mitigation site for the California red-legged frog and the California tiger salamander at the east end of the project area and north of State Route 84. The site was established to mitigate for impacts resulting from of the Ruby Hills and Vineyard Estates subdivision. Juvenile salamanders were observed during fairy shrimp surveys in seasonal pools within the action area. Suitable California tiger salamander habitat in the form of grasslands is abundant in the action area (Nagano pers. obs. November 2004; California Department of Transportation 2002). There is an abundance of ground squirrels, whose burrows provide underground upland habitat for the amphibian (Nagano pers. obs. November 2004; California Department of Transportation 2004). Therefore, the Service has determined it is reasonable to conclude the California tiger salamander inhabits the action area, based on the biology and ecology of the species, the presence of suitable habitat, as well as the recent observations of this animal.

**California Tiger Salamander Proposed Critical Habitat**

Critical habitat for the California tiger salamander was proposed on August 10, 2004 (U.S. Fish and Wildlife Service 2004). The Service divided the current range of the Central population into four regions: (1) Central Valley; (2) Southern San Joaquin Valley; (3) East Bay; and (4) Central Coast. The project area is located in the East Bay region.

The Service determined that conserving the California tiger salamander over the long-term requires a five-pronged approach: (1) Maintaining the current genetic structure across the species range; (2) maintaining the current geographical, elevational, and ecological distribution; (3) protecting the hydrology and water quality of breeding pools and ponds; (4) retaining or providing for connectivity between locations for genetic exchange and recolonizaiton; (5) protecting sufficient barrier-free upland habitat around each breeding location to allow for sufficient survival and recruitment to maintain a breeding population over the long-term (U.S. Fish and Wildlife Service 2004).

The Service believes that areas proposed for critical habitat may require certain management considerations or protections due to the following threats: (1) Activities that introduce or promote the occurrence of bullfrogs and fish; (2) Activities that could disturb aquatic habitats during the breeding season; (3) Activities that impair the water quality of aquatic breeding habitats; ( 4) Activities that would reduce small mammal populations to the point that there is insufficient underground Central population refugia used for foraging, protection from predators, and shelter from the elements; (5) Activities that create barriers impassible for salamanders or road crossings that increase mortality in upland habitat between extant occurrences in breeding habitat; (6) Activities on adjacent uplands that disrupt vernal pool complexes' ability to support California tiger salamander breeding function; (7) Activities that introduce non-native tiger protection form the elements and form predation. Although California tiger salamander are members of a family of burrowing tiger salamanders, California tiger salamander are not known to create their own burrows in the wild and require small mammal burrows for survival. The upland component of the Central population habitat typically consists of vernal pool grassland or grassland savannah with scattered oak trees. However, some occupied California tiger salamander breeding ponds exist within mixed grassland and woodland habitats, in woodlands, scrub, or chaparral habitats (U.S. Fish and Wildlife Service 2004).

*Dispersal and Migration.* Movements made by California tiger salamander can be grouped into two main categories: (1) Breeding migration, and (2) interpond dispersal. Breeding migration is the movement of salamanders to and from a pond from the surrounding upland habitat. After metamorphosis, juveniles move away from breeding ponds into the surrounding uplands, where they live continuously for several years (on average, four years). Upon reaching sexual maturity, most individuals return to their natal (birth) pond to breed, while 20 percent disperse to other ponds (U. S. Fish and Wildlife Service 2004).

Essential dispersal habitats generally consist of upland areas adjacent to essential aquatic habitats which are not isolated from other essential aquatic habitats by barriers that California tiger salamander cannot cross. Essential dispersal habitats provide connectivity among California tiger salamander suitable aquatic and upland habitats. While California tiger salamander can bypass many obstacles, and do not require a particular type of habitat for dispersal, the habitats connecting essential aquatic and upland habitats need to be free of barriers (*e.g.* a physical or biological feature that prevents salamanders from dispersing beyond the feature) to function effectively (U. S. Fish and Wildlife Service 2004).

The Service proposed critical habitat that allowed for dispersal between extant occurrences within 0.7 mile of each other. This distance was selected because it provides for 99 percent of the chances that individual salamanders can move and breed between extant occurrences, and, thereby, provides for genetic exchange between individual within the region (U.S. Fish and Wildlife Service 2004).

The proposed Pigeon Pass Project is located in Unit 3 of critical habitat proposed by the Service (U.S. Fish and Wildlife Service 2004b). The project area is relatively undeveloped, with the highway corridor, the Ruby Hills and Vineyard Estates developments, and several ranches in the project vicinity. The surrounding habitat includes several vegetation communities, including valley oak woodland, annual non-native grassland, seasonally wetted areas with associated vegetation, and ponds. A 60-acre California red-legged frog/California tiger salamander mitigation site for the Ruby Hills/Vineyard Estates consists of a series of artificial ponds connected by drainages, and the surrounding upland habitat. As described in the Biological Assessment, essentially all undeveloped lands on and adjacent to the action area contain the constituent elements of proposed California tiger salamander critical habitat, including aquatic habitat, associated uplands, and dispersal habitat.

However, frogs also have been found in ephemeral creeks and drainages and in ponds that may or may not have riparian vegetation. The largest densities of California red-legged frogs currently are associated with deep pools with dense stands of overhanging willows (*Salix* spp.) and an intermixed fringe of cattails (*Typha latifolia*) (Jennings 1988). California red-legged frogs disperse upstream and downstream of their breeding habitat to forage and seek sheltering habitat. Sheltering habitat for California red-legged frogs is potentially all aquatic, riparian, and upland areas within the range of the species and includes any landscape features that provide cover, such as existing animal burrows, boulders or rocks, organic debris such as downed trees or logs, and industrial debris. Agricultural features such as drains, watering troughs, spring boxes, abandoned sheds, or hay ricks may also be used. Incised stream channels with portions narrower than 46 centimerts (18 inches) and depths greater than 46 cm (18 in) may also provide important summer sheltering habitat. Accessability to sheltering habitat is essential for the survival of California red-legged frogs within a watershed, and can be a factor limiting frog population numbers and survival. During winter rain events, juvenile and adult California red-legged frogs are known to disperse up to 0.54-1.08 miles (Rathbun and Holland, unpublished data, cited in Rathbun *et al.* 1997). Dispersing frogs in northern Santa Cruz County traveled distances from 0.25 mile to more than 2 miles without apparent regard to topography, vegetation type, or riparian corridors (Bulger, unpublished data).

Egg masses contain about 2,000 to 5,000 moderate sized (0.08 to 0.11 inches in diameter), dark reddish brown eggs and are typically attached to vertical emergent vegetation, such as bulrushes (*Scirpus* spp.) or cattails (Jennings *et al.* 1992). California red-legged frogs are often prolific breeders, laying their eggs during or shortly after large rainfall events in late winter and early spring (Hayes and Miyamoto 1984). Eggs hatch in 6 to 14 days (Jennings 1988). In coastal lagoons, the most significant mortality factor in the pre-hatching stage is water salinity (Jennings *et al.* 1992); eggs exposed to salinity levels greater than 4.5 parts per thousand result in 100 percent mortality (Jennings and Hayes 1990). Increased siltation during the breeding season can cause asphyxiation of eggs and small larvae. Larvae undergo metamorphosis 3.5 to 7 months after hatching (Storer 1925; Wright and Wright 1949; Jennings and Hayes 1990). Of the various life stages, larvae probably experience the highest mortality rates, with less than 1 percent of eggs laid reaching metamorphosis (Jennings *et al.* 1992). Sexual maturity normally is reached at 3 to 4 years of age (Storer 1925; Jennings and Hayes 1985). California red-legged frogs may live 8 to 10 years (Jennings *et al.* 1992). Populations of California red-legged frogs fluctuate from year to year. When conditions are favorable California red-legged frogs can experience extremely high rates of reproduction and thus produce large numbers of dispersing young and a concomitant increase in the number of occupied sites. In contrast, California red-legged frogs may temporarily disappear from an area when conditions are stressful (e.g., drought).

The diet of California red-legged frogs is highly variable. Hayes and Tennant (1985) found invertebrates to be the most common food items. Vertebrates, such as Pacific tree frogs (*Hyla regilla*) and California mice (*Peromyscus californicus*), represented over half the prey mass eaten by larger frogs (Hayes and Tennant 1985). Hayes and Tennant (1985) found juvenile frogs to be active diurnally and nocturnally, whereas adult frogs were largely nocturnal. Feeding activity probably occurs along the shoreline and on the surface of the water (Hayes and Tennant 1985). Tadpoles likely eat algae (Jennings *et al.* 1992).

Santa Clara County, includes the eastern portion of San Mateo County, and all of San Francisco County (U. S. Fish and Wildlife Service 2002). Contra Costa and Alameda counties contain the majority of known California red-legged frog localities within the eastern San Francisco Bay area. Within this recovery unit, the listed amphibian seem to have been nearly eliminated from the western lowland areas near urbanization, they still occur in isolated populations in the East Bay Foothills (between Interstate 580 and Interstate 680), and are abundant in several areas in the eastern portions of Alameda and Contra Costa counties. This recovery unit is essential to the survival and recovery of California red-legged frogs, as it contains the largest number of occupied drainages in the northern portion of its range. The eastern and western edges of this area are heavily urbanized and the northern and southern edges are bounded by major highways. However, there are numerous small drainages flowing underneath both Interstate 580 and Highway 84 that California red-legged frogs could disperse through. Therefore, this area is connected to other populations of red-legged frogs in the foothills of central Alameda and Contra Costa Counties and the populations found in eastern Alameda County. Within this area, the species historically bred in several ponds and drainages within the proposed project area, Garin/Dry Creek Regional Park, Pleasanton Ridge Regional Park, and Sinbad Creek.

There are several recent sightings of the California red-legged frog in the action area and throughout the region south of Livermore (California Department of Fish and Game 2004; California Department of Transportation 2004). Surveys for the vernal pool fairy shrimp conducted by California Department of Transportation in the Pigeon Pass Project action area detected California red-legged frog egg masses (California Department of Transportation 2004). Habitat of this listed species occurs along the entire Pigeon Pass Project corridor, and includes several drainage crossings. Adult California red-legged frogs are highly mobile and may move considerable distances from their breeding ponds. Areas containing aquatic and upland habitat exist within and adjacent to the action area (Nagano pers. obs. November 2004). The action area contains components that can be used by the California red-legged frog for feeding, resting, mating, movement corridors, and other essential behaviors. Therefore, the Service believes that the California red-legged frog is reasonably certain to occur within the action area because of the biology and ecology of the animal, the presence of suitable habitat in and adjacent to the action area, as well as the recent observations of this listed species.

**California Red-Legged Frog Proposed Critical Habitat**

On March 13, 2001, the final rule determining critical habitat for red-legged frogs was published in the Federal Register (U.S. Fish and Wildlife Service 2001). This rule established 31 critical habitat units based on three primary constituent elements: (a) essential aquatic habitat; (b) associated uplands; and (c) dispersal habitat connecting essential aquatic habitat. In November 2002, the U.S. District Court for the District of Columbia vacated most of the 2001 designation and ordered the Service to publish a new critical habitat proposal. On April 13, 2004, the Service re-proposed 4.1 million acres in 28 California counties as critical habitat for the frog (U.S. Fish and Wildlife Service 2004). This proposed rule basically re-proposes the same areas designated critical habitat in the 2001 final rule.

Associated upland and riparian habitat is essential to maintain California red-legged frog populations associated with essential aquatic habitat. The associated uplands and riparian habitat provide food and shelter sites for California red-legged frogs, and assist in maintaining the integrity of aquatic sites by protecting them from disturbance and supporting the normal functions of the aquatic habitat. Key conditions include the timing, duration, and extent of water moving within the system, filtering capacity, and maintaining the habitat to favor red-legged frogs and discourage the colonization of nonnative species such as bullfrogs. Essential upland habitat consists of all upland areas within 300 feet, or no further than the watershed boundary, of the edge of the ordinary high-water mark of essential aquatic habitat (U.S. Fish and Wildlife Service 2001a).

Essential dispersal habitat provides connectivity among California red-legged frog breeding habitat (and associated upland) patches. While frogs can pass many obstacles, and do not require a particular type of habitat for dispersal, the habitat connecting essential breeding locations and other aquatic habitat must be free of barriers (e.g., a physical or biological feature that prevents frogs from dispersing beyond the feature) and at least 300 feet wide. Essential dispersal habitat consists of all upland and wetland habitat free of barriers that connects two or more patches of essential breeding habitat within 1.25 miles of one another. Dispersal barriers include heavily traveled roads (an average of 30 cars per hour from 10:00 p.m. to 4:00 a.m.) that possess no bridges or culverts; moderate to high density urban or industrial developments; and large reservoirs more than 50 acres in size. Agricultural lands such as row crops, orchards, vineyards, and pastures do not constitute barriers to California red-legged frog dispersal.

*Dispersal habitat connecting essential aquatic habitat.* Essential dispersal habitat provides connectivity among red-legged frog breeding habitat (and associated upland) patches. While frogs can pass many obstacles, and do not require a particular type of habitat for dispersal, the habitat connecting essential breeding locations and other aquatic habitat must be free of barriers (*e.g.*, a physical or biological feature that prevents frogs from dispersing beyond the feature) and at least 300 feet wide. Essential dispersal habitat consists of all upland and wetland habitat free of barriers that connects two or more patches of essential breeding habitat within 1.25 miles of one another. Dispersal barriers include heavily traveled roads (an average of 30 cars per hour from 10:00 p.m. to 4:00 a.m.) that possess no bridges or culverts; moderate to high density urban or industrial developments; and large reservoirs more than 50 acres in size. Agricultural lands such as row crops, orchards, vineyards, and pastures do not constitute barriers to red-legged frog dispersal.

The Pigeon Pass Project occurs within the East Bay-Diablo Range unit (Unit 15), which consists of watersheds within Contra Costa, Alameda, San Joaquin, Santa Clara, Stanislaus, San Benito, Merced, and Fresno counties. The boundary of Unit 15 encompasses approximately 1.05 million acres, of which approximately 87 percent is privately owned. The remaining 13 percent is managed, in part, by various Federal, State, and local land and water management agencies. Because essential aquatic habitat, associated uplands, and essential dispersal habitat has not been widely mapped in the unit, the Service can not accurately estimate the area within the unit that supports primary constituent elements. However, due to the presence of high use roads and species has been found include Northern Hardpan, Northern Claypan, Northern Volcanic Mud Flow, and Northern Basalt Flow vernal pools formed on a variety of geologic formations and soil types. Although vernal pool fairy shrimp have been collected from large vernal pools, including one exceeding 25 acres in area (Eriksen and Belk 1999), it is most frequently found in pools measuring fewer than 0.05 acre in area (Helm 1998; Gallagher 1996). The species occurs at elevations from 33 feet to 4,003 feet (Eng *et al.* 1990), and is typically found in pools with low to moderate amounts of salinity or total dissolved solids (Keeley 1984; Syrdahl 1993). Vernal pools are mostly rain fed, resulting in low nutrient levels and dramatic daily fluctuations in pH, dissolved oxygen, and carbon dioxide (Keeley and Zedler 1998). Although there are many observations of the environmental conditions where vernal pool fairy shrimp have been found, there have been no experimental studies investigating the specific habitat requirements of this species.

The hydrology that maintains the pattern of inundation and drying characteristic of vernal pool habitats is complex. Vernal pool habitats form in depressions above an impervious soil layer (duripan) or rock substrate. After winter rains begin, this impervious layer prevents the downward percolation of water and creates a perched water table causing the depression (or pool) to fill. Due to local topography and geology, the depressions are generally part of an undulating landscape, where soil mounds are interspersed with basins, swales, and drainages (Nikiforoff 1941; Holland and Jain 1978). These features form an interconnected hydrological unit known as a vernal pool complex. Although vernal pool hydrology is driven by the input of precipitation, water input to vernal pool basins also occurs from surface and subsurface flow from the swale and upland portions of the complex (Zedler 1987, Hanes *et al.* 1990, Hanes and Stromberg 1998). Surface flow through the swale portion of the complex allows vernal pool species to move directly from one vernal pool to another. Upland areas are a critical component of vernal pool hydrology because they directly influence the rate of vernal pool filling, the length of the inundation period, and the rate of vernal pool drying (Zedler 1987; Hanes and Stromberg 1998).

The vernal pool fairy shrimp has evolved unique physical adaptations to survive in vernal pools. Vernal pool environments are characterized by a short inundation phase during the winter, a drying phase during the spring, and a dry phase during the summer (Holland and Jain 1978). The timing and duration of these phases can vary significantly from year to year, and in some years vernal pools may not inundate at all. In order to take advantage of the short inundation phase, vernal pool crustaceans have evolved short reproduction times and high reproductive rates. The listed crustaceans generally hatch within a few days after their habitats fill with water, and can start reproducing within a few weeks (Eng *et al.* 1990; Helm 1998; Eriksen and Belk 1999). Vernal pool crustaceans can complete their entire life cycle in a single season, and some species may complete several life cycles. Vernal pool crustaceans can also produce numerous offspring when environmental conditions are favorable. Some species may produce thousands of cysts during their life spans.

To survive the prolonged heat and dessication of the vernal pool dry phase, vernal pool crustaceans have developed a dormant stage. After vernal pool crustacean eggs are fertilized in the female's brood sac, the embryos develop a thick, usually multi-layered shell. When embryonic development reaches a late stage, further maturation stops, metabolism is drastically fairy shrimp within a single wet season, and Gallagher (1996) observed 3 separate hatches in vernal pools in Butte County.

Helm (1998) observed vernal pool fairy shrimp living for as long as 147 days. The species can reproduce in as few as 18 days at optimal conditions of 68°F and can complete its life cycle in as little as 9 weeks (Gallagher 1996; Helm 1998). However, maturation and reproduction rates of vernal pool crustaceans are controlled by water temperature and can vary greatly (Eriksen and Brown 1980; Helm 1998). Helm (1998) observed that vernal pool fairy shrimp did not reach maturity until 41 days at water temperatures of 59°F. Vernal pool fairy shrimp has been collected at water temperatures as low as 40°F (Eriksen and Belk 1999), however, the species has not been found in water temperatures above about 73°F (Helm 1998; Eriksen and Belk 1999).

The vernal pool fairy shrimp is known from 32 populations extending from Stillwater Plain in Shasta County through most of the length of the Central Valley to Pixley in Tulare County, and along the central coast range from northern Solano County to Pinnacles in San Benito County (Eng et al. 1990; Fugate 1992; Sugnet and Associates 1993) and a disjunct population on the Agate Desert in Oregon. Five additional, disjunct populations exist: one near Soda Lake in San Luis Obispo County; one in the mountain grasslands of northern Santa Barbara County; one on the Santa Rosa Plateau in Riverside County, one near Rancho California in Riverside County and one on the Agate Desert near Medford, Oregon. Three of these isolated populations each contain only a single pool known to be occupied by the vernal pool fairy shrimp. The genetic characteristics of these species, as well as ecological conditions, such as watershed continuity, indicate that populations of these animals are defined by pool complexes rather than by individual vernal pools (Fugate 1992). Therefore, the most accurate indication of the distribution and abundance of these species is the number of inhabited vernal pool complexes. Individual vernal pools occupied by these species are most appropriately referred to as subpopulations.

The primary historic dispersal method for the vernal pool fairy shrimp likely was large scale flooding resulting from winter and spring rains which allowed the animals to colonize different individual vernal pools and other vernal pool complexes. This dispersal currently is non-functional due to the construction of dams, levees, and other flood control measures, and widespread urbanization within significant portions of the range of this species. Waterfowl and shorebirds likely are now the primary dispersal agents for vernal pool tadpole shrimp and vernal pool fairy shrimp (Brusca in. litt.; 1992, King in. litt., 1992; Simovich in. litt., 1992). The eggs of these crustaceans are either ingested (Krapu 1974; Swanson *et al.* 1974; Driver 1981; Ahl 1991) and/or adhere to the legs and feathers where they are transported to new habitats.

Vernal pool crustaceans are often dispersed from one pool to another through surface swales that connect one vernal pool to another. These dispersal events allow for genetic exchange between pools and create a population of animals that extends beyond the boundaries of a single pool. Instead, populations of vernal pool crustaceans are defined by the entire vernal pool complex in which they occur (Simovich *et al.* 1992, King 1996). These dispersal events also allow vernal pool crustaceans to move into pools with a range of sizes and depths. In dry years, animals may only emerge in the largest and deepest pools. In wet years, animals may be present in all pools, that a historic loss between 60 and 85 percent may be more accurate. Regardless, in the ensuing years, threats to this habitat type have continued and resulted in a substantial amount of vernal pool habitat being converted for human uses in spite of Federal regulations implemented to protect wetlands. For example, the Corps' Sacramento District has authorized the filling of 467 acres of wetlands between 1987 and 1992 pursuant to Nationwide Permit 26 (U.S. Fish and Wildlife Service 1992). The Service estimates that a majority of these wetland losses within the Central Valley involved vernal pools, the habitat of the vernal pool tadpole shrimp and vernal pool fairy shrimp. Current rapid urbanization and agricultural conversion throughout the ranges of these two species continue to pose the most severe threats to the continued existence of the vernal pool tadpole shrimp and vernal pool fairy shrimp. The Corps' Sacramento District has several thousand vernal pools under its jurisdiction (Coe 1988), which includes most of the known populations of these listed species. It is estimated that within 20 years 60 to 70 percent of these pools will be destroyed by human activities (Coe 1988).

In addition to direct habitat loss, the vernal pool habitat for the vernal pool tadpole shrimp and vernal pool fairy shrimp has been and continues to be highly fragmented throughout their ranges due to conversion of natural habitat for urban and agricultural uses. This fragmentation results in small isolated vernal pool tadpole shrimp and vernal pool fairy shrimp populations. Ecological theory predicts that such populations will be highly susceptible to extirpation due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1986; Goodman 1987a, 1987b). If an extirpation event occurs in a population that has been fragmented, the opportunities for recolonization would be greatly reduced due to physical (geographical) isolation from other (source) populations.

In addition to direct habitat loss, the vernal pool habitat for this listed vernal pool crustacean is also highly fragmented throughout their ranges due to the nature of vernal pool landscapes and the conversion of natural habitat by human activities. Such fragmentation results in small, isolated populations of listed crustaceans which may be more susceptible to extinction due to random demographic, genetic, and environmental events. Should an extirpation event occur in a population that has been fragmented, the opportunities for recolonization would be greatly reduced due to physical (geographical) isolation from other (source) populations.

Vernal pools and ephemeral wetlands are found at seven sites in the action area of the Pigeon Pass Project (California Department of Transportation 2004). Service-approved protocols for sampling for the listed crustacean were not followed at the proposed project. Two of the seven sites were not sampled for vernal pool crustaceans because they were located more than 250 feet from the construction area. Back-to-back dry and wet season surveys were conducted at the remaining five sites (California Department of Transportation 2004). Cysts of fairy shrimp of the genus *Branchinecta* were found at one of the pools; however, the specific identity was not determined. This vernal pool is in the right-of-way and cut-and-fill limits for the Pigeon Pass Project, and will be partially filled as a result of the proposed action. Surveys were discontinued at one of the sites when California red-legged frog egg masses were discovered, however, that site is over 250 feet from the zone of disturbance. The vernal pool fairy shrimp has been recorded within 7 miles of the proposed project (California Department of Fish and Game 2004) and suitable habitat for this listed animal is found in the action area of the project. Therefore, the such factors as the sizes or other data that would have allowed an adequate evaluation of the effectiveness of this proposed conservation measure.

Construction equipment that has been used in different areas and with different species of amphibians including the California tiger salamander and the California red-legged frog may transmit diseases by introducing contaminated soil and other material on the equipment. The chance of a disease being introduced into a new area is greater today than in the past due to the increasing occurrences of disease throughout amphibian populations in California and the United States. It is possible that chytrid fungus may exacerbate the effects of other diseases on amphibians or increase the sensitivity of the amphibian to environmental changes (*e.g.*, water pH) that reduce normal immune response capabilities (Bosch *et al.* 2000).

This conference opinion on the proposed critical habitats for the California tiger salamander and the California red-legged frog does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR § 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in *Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service* (No. 03-35279) to complete the following analysis with respect to the proposed critical habitats.

<u>San Joaquin Kit Fox</u>

Individual San Joaquin kit foxes may be directly injured or killed by activities that disturb feeding, breeding, and sheltering habitat. The proposed project would (1) result in the permanent loss of 17.3 acres and the temporary loss of 61.9 acres of San Joaquin kit fox habitat; (2) result in the possible injury and death of an unknown number of San Joaquin kit foxes; (3) result in construction-related harassment to the surviving San Joaquin kit foxes on the site; (4) impede the dispersal of San Joaquin kit foxes through the site while the action is in progress; (5) increase the likelihood of predation on San Joaquin kit foxes; and (6) fragment and reduce the amount of San Joaquin kit fox habitat in the northern portion of the range of this species

Construction related activities are likely to cause disruption of foraging, disruption or complete loss of reproduction, harassment from increased human activity, and permanent and temporary loss of shelter. Because these animals are nocturnal, when construction is performed at night, associated lighting likely would increase all of the above effects. Lighting associated with night construction will also increase the likelihood of predation on San Joaquin kit foxes by removing the cover of darkness. The animals that avoid construction activities may become displaced into adjacent areas. Nocturnally active mammalian predators may be vulnerable to increased predation, exposure, starvation, or stress through disorientation, loss of shelter, and intraspecific and interspecific aggression (Grigione 2002).

Range-wide habitat loss, fragmentation, and degradation from multiple factors is the primary threat to the San Joaquin kit fox (U.S. Fish and Wildlife Service 1998). Approximately 95% of native habitat for kit fox habitat in the San Joaquin Valley ha been destroyed by agricultural, industrial, and urban development (U.S. Fish and Wildlife Service 1998). Loss of natural lands continues to occur further reducing the habitat available for the animal. The amount of historical reluctance to cross roads (Barnum 1999) as do mountain lions (*Felis concolor*)(Van Dyke *et al.* 1986). In a study in North Carolina, the number of road crossings by black bears (*Ursus americanus*) was inversely related to traffic volume, and bears almost never crossed an interstate highway (Brody and Pelton 1989). Endangered Sonoran pronghorn (*Antilocarpa americana*) in Mexico are reluctant to cross a 2-lane highway, and the planned expansion of the road could further restrict movements (Castillo-Sanchez 1999). Many rodents are reluctant to cross roads (Oxley *et al.* 1974).

The inhibition of animal movements caused by roads produces a significant effect by fragmenting habitats and populations (Joly and Morand 1997). Roads were found to be significant barriers to gene flow among common frogs (*Rana temporaria*) in Germany and this has resulted in genetic differentiation among populations separated by roads (Reh and Seitz 1990). Similarly, significant genetic subdivision was detected in bank voles (*Clethrionomys glarelous*) populations separated by a 50-meter (164 foot) wide highway in Germany (Gerlach and Musolf 2000). In California, local extirpations of mountain lions has occurred when roads and other developments fragmented habitat in small patches and blocked movement corridors thereby isolating the patches and preventing recolonization (Beier 1993). Adequately sized culverts or undercrossings with suitable habitat at each side of the passage significantly increases the ability of mammals to cross highways (Ng *et al.* 2003).

San Joaquin kit fox mortality and injury occurs when the animals attempt to cross roads and are hit by cars, trucks, or motorcycles. The majority of strikes likely occur at night when the animals are most active. Driver visibility also is lower at night increasing the potential for strikes. Such strikes are usually fatal for an animal the size of a San Joaquin kit fox. Thus, vehicle strikes are a direct source of mortality for this listed canine. If vehicle strikes are sufficiently frequent in a given locality, they could result in reduced San Joaquin kit fox abundance. The death of animals during the November-January breeding season could result in reduced reproductive success. Death of females during gestation or prior to pup weaning could result in the loss of an entire litter of young, and therefore, reduced recruitment of new individuals into the population.

Occurrences of vehicle strikes involving San Joaquin kit foxes have been well documented, and such strikes occur throughout the range of the species. Sources of kit fox mortality were examined during 1980-1995 at the Naval Petroleum Reserve in California in western Kern County (Cypher *et al.* 2000). During this period, 341 adult San Joaquin kit foxes were monitored using radio telemetry, and 225 of these animals were recovered dead. Of these, 20 were struck by vehicles; 9% of adult kit mortalities were attributed to vehicles, and 6% of all monitored adults were killed by vehicles. During this same period, 184 juvenile (<1 year old) kit foxes were monitored. Of these, 142 were recovered dead and 11 were killed by vehicles; 8% of juvenile kit fox mortalities were attributed to vehicles and 6% of all monitored juveniles were killed by vehicles. For both adults and juveniles, vehicle strikes accounted for less than 10% of all San Joaquin kit fox deaths in most years. However, in some years, vehicles accounted for about 20% of deaths. Predators, primarily coyotes and bobcats, were the primary source of mortality at the Naval Petroleum Reserves. In addition, 70 kit foxes, both radio collared and non-collared, were found dead on roads in and around the Naval Petroleum Reserve during 1980-1991 (U.S. Department of Energy 1993). Of these, 34 were hit by vehicles on the approximately which the animals cross roads and are therefore at risk. The proportion of successful road crossings by these animals likely declines with increasing road size, traffic volume and density, and vehicle speeds. The proportion of San Joaquin kit foxes successfully crossing roads may increase in areas where they obtain more experience crossing roads, such as in and near urban areas.

Based on a study of another kit fox subspecies, Egoscue (1962) reported that 8 tagged foxes (*Vulpes macrotis nevadensis*) in Utah were killed by vehicles, and 5 of these were pups. Pups appeared to be more vulnerable to vehicle strikes. Many of the foxes killed were residents that were using dens located near roads. O'Neal *et al* (1987) examined 23 dead kit foxes in western Utah in 1983. None were killed by vehicles, possibly due to the remoteness of the study site.

Swift foxes (*Vulpes velox*) are closely related to the San Joaquin kit fox, and are listed as an endangered in Canada. They show numerous ecological similarities with the San Joaquin kit fox. Hines (1980) reported that roads were a major source of swift fox mortality in Nebraska. In Alberta, where the swift fox was extirpated and recently reintroduced, vehicles were responsible for 5 of 89 (6%) of the foxes found dead (Cabyn *et al* 1994). Pups appeared to be especially vulnerable, particularly if the natal dens were located near roads (Cabyn 1998). In western Kansas, 41 adults and 24 juvenile swift foxes were radio collared and monitored during 1996-97 on 2 study sites (Sovada *et al* 1998). Among the adults, 18 were found dead, but none were killed by vehicles. Among the juveniles, 14 were found dead and 4 (29%) of these had been struck by vehicles. All 7 of the juveniles killed by vehicles were found on the same study site. This study site had 90% more roads compared to the other study site where no foxes were killed by vehicles (78 miles vs. 41 miles). At a remote site in Colorado with few roads and restricted public access, swift foxes were rarely struck by vehicles (Covell 1992; Kitchen *et al.* 1999).

Vehicle-related mortality has significantly affected other listed or rare species. Vehicles caused 49% of the mortality documented among endangered Florida panthers (*Felis concolor coryi*) (Maehr *et al.* 1991). With a small remaining population, the loss of any individuals to vehicles could constitute a significant population effect. Similarly, at least 15% of the remaining 250-300 key deer (*Odocileus virginianus clavium*) are killed annually by vehicles (Tubak 1999), and this mortality is considered to be a limiting factor for this endangered species (U.S. Fish and Wildlife Service 1985). Mortality from vehicles was the primary source of mortality for endangered ocelots (*Felis pardalis*) in Texas (Tubak 1999), and also contributed to the failure of a lynx (*Lynx lynx*) reintroduction project in New York (Aubrey *et al.* 1999). Rudolph *et al.* (1999) estimated that road-associated mortality may have depressed populations of Louisiana pine snakes (*Pituophis ruthveni*) and timber rattlesnakes (*Crotalus horridus*) by over 50% in eastern Texas, and this mortality may be a primary factor in local extirpations of timber rattlesnakes (Rudolph *et al.* 1998). Mortality from vehicles also is contributing to the reduction in the status of the prairie garter snake (*Thamnophis radix radix*) in Ohio (Dalrymple and Reichenbach 1984), and was a limiting factor in the recovery of the endangered American crocodile (*Crocodylus acutus*) in Florida (Kushland 1998). In Florida, threatened Florida scrub-jays (*Aphelocoma coerulescens*) suffered higher mortality in territories near roads, as well as reduced productivity due to vehicle strikes of both breeding adults and young (Mumme et al. 1999).

source (Komanoff & Shaw 2000). For instance, a noise that measured 20 dBA at 60 feet registers 10 dBA at 40 meters.

Harassment from long-term noise may cause San Joaquin kit foxes to eventually vacate the project site and adjacent areas. Endangered California condors (*Gymnogyps californianus*) have been shown to abandon nesting sites in response to vehicle noise (Shaw 1970). Grizzly bears (*Ursus arctos*), mountain goats (*Oreamnos canadensis*), caribou (*Rangifer* species), and bighorn sheep (*Ovis* spp.) have all been found to abandon foraging or calving areas in response to aircraft noise (Chadwick 1973; McCourt *et al.* 1974; Ballard 1975; Krausman and Hervert 1983; Gunn *et al.* 1985; Bleich 1990; all cited in U.S. National Park Service 1994).

Project effects on San Joaquin kit foxes are expected to be greater during the den selection, pregnancy, and early pup dependency periods of the breeding cycle (December through July) than at other times of the year. San Joaquin kit foxes may exhibit increased sensitivity to disturbance during this period and therefore, ideally, surface-disturbing activities should occur between August and November. Habitat compensation measures are anticipated to minimize habitat effects that result from implementation of the project.

The presence of roads in an area could result in the introduction of chemical contaminants to the site. Contaminants could be introduced in several ways. Substances used in road building materials or to recondition roads can leach out or wash off roads adjacent habitat. Vehicle exhaust emissions can include hazardous substances which may concentrate in soils along roads. Heavy metals such as lead, aluminum, iron, cadmium, copper, manganese, titanium, nickel, zinc, and boron are all emitted in vehicle exhaust (Trombulak and Frissell 2000). Concentrations of organic pollutants (e.. Dioxins, polychlorinated biphenyls) are higher in soils along roads (Benfenati *et al.* 1992). Ozone levels are higher in the air near roads (Trombulak and Frissell 2000). Vehicles may leak hazardous substances such as motor oil and antifreeze. Although the quantity leaked by a given vehicle may be minute, these substances can accumulate on roads and then get washed into the adjacent environment by runoff during rain storms. An immense variety of substances could be introduced during accidental spills of materials. Such spills can result from small containers falling off passing vehicles, or from accidents resulting in whole loads being spilled. Large spills may be partially or completely mitigated by clean-up efforts, depending on the substance.

San Joaquin kit foxes using areas adjacent to roads could be exposed to any contaminants that are present at the site. Exposure pathways could include inhalation, dermal contact, direct ingestion, ingestion of contaminated soil or plants, or consumption of contaminated prey. Exposure to contaminants could cause short- or long-term morbidity, possibly resulting in reduced productivity or mortality. Carcinogenic substances could cause genetic damage resulting in sterility, reduced productivity, or reduced fitness among progeny. Contaminants also may have the same effect on kit fox prey species. This could result in reduced prey abundance and diminished local carrying capacity for the kit fox.

Little information is available on the effects of contaminants on the San Joaquin kit fox. The effects may be difficult to detect. Morbidity or mortality likely would occur after the animals had due to the presence of humans. Roads may facilitate movements of red foxes and increase access to kit fox habitat. Non-native red foxes and feral cats (*Felis catus*) are reported to use roads as movement corridors in Australia (Bennett 1991).

Negative effects to wildlife populations from roads may extend some distance from the actual road. The phenomenon can result from any of the effects already described in this biological opinion (e.g. vehicle-related mortality, habitat degradation, invasive exotic species, etc.). Forman and Deblinger (1998) described the area affected as the "road effect" zone. Along a 4-lane road in Massachusetts, they determined that this zone extend for an average of approximately 980 feet to either side of the road for an average total zone width of approximately 1970 feet. However, in places they detected an effect > 0.6 mile from the road. Rudolph *et al* (1999) detected reduced snake abundance up to 2790 feet from roads in Texas. They estimated snake abundance out to 2790 feet, so the effect may have been greater. Extrapolating to a landscape sale, they concluded the effect of roads on snake populations in Texas likely was significant, given that approximately 79% of the land area of the Lone Star State is within 1640 feet of a road. The "road-zone" effects can be subtle. Van der Zandt *et al.* (1980) reported that lapwings (*Vanellus vanellus*) and black-tailed godwits (*Limosa limosa*) feeding at 1575-6560 feet from roads were disturbed by passing vehicles. The heart rate, metabolic rate and energy expenditure of female bighorn sheep (*Ovis canadensis*) increases near roads (MacArthur *et al.* 1979). Trombulak and Frossell (2000) described another type of "road-zone' effect. Heavy metal concentrations from vehicle exhaust were greatest within 66 feet of roads, by elevated levels of metals in both soil and plants were detected at ≥660 feet) of roads. The "road-zone" apparently varies with habitat type and traffic volume. Based on responses by birds, Forman (2000) estimated the effect zone along primary roads of 1000 feet in woodlands, 1197 feet in grasslands, and 2657 feet in natural lands near urban areas. Along secondary roads with lower traffic volumes, the effect zone was 656 feet. The "road zone" and the San Joaquin kit fox has not been adequately investigated; however, it is possible it exists given the effects of roads on the animal.

California Tiger Salamander

The proposed Pigeon Pass Project is likely to result in a number of adverse effects to the California tiger salamander. The proposed project will eliminate and fragment the habitat of the listed amphibian, and increase levels of mortality of the animal during its movements between the breeding ponds and upland habitat. Individuals exposed during excavations likely will be crushed and killed or injured by construction-related activities. Salamanders also could fall into the trenches, pits, or other excavations, and then they could be directly killed or be unable to escape and be killed due to dessication, entombment, or starvation. The amphibians could be subject to increased levels of harassment resulting from lights used during night time construction. Edible trash left during or after repair activities could attract predators, such as racoons, crows, and ravens, to the sites, who could subsequently prey on the listed amphibian. Salamanders also may become trapped if plastic mono-filament netting is used for erosion control or other purposes where they would be subject to death by predation, starvation, or dessication (Stuart *et al.* 2001). The increased width of the road and higher levels of vehicle traffic will result in higher numbers of California tiger salamanders killed during their patch. The possibility for recolonization will depend upon the nature of the factors, e.g., roads, canals, development, etc., that are causing the fragmentation.

Fragmentation factors that effectively isolate patches and limit access also constitute barriers to California tiger salamander dispersal, and gene flow. Movements and dispersal corridors between breeding ponds and upland habitat are critical to this animal's population dynamics, particularly because the animals currently persist as metapopulations with multiple disjunct population centers. Movement and dispersal corridors likely are important for alleviating over-crowding during years when California tiger salamander abundance is high, and also they are important for facilitating the recolonization of areas where the animal has been extirpated. Movement between population centers maintains gene flow and reduced genetic isolation. Genetically isolated populations are at greater risk of deleterious genetic effects such as inbreeding, genetic drift, and founder effects.

Roads have been documented as barriers to movements by a diversity of species, and this effect varies with road size and traffic volume. The inhibition of animal movements caused by roads produces a significant effect by fragmenting habitats and populations (Joly and Morand 1997). Roads were found to be significant barriers to gene flow among common frogs (*Rana temporaria*) in Germany and this has resulted in genetic differentiation among populations separated by roads (Reh and Seitz 1990). Similarly, significant genetic subdivision was detected in bank voles (*Clethrionomys glarelous*) populations separated by a 50-meter (164 foot) wide highway in Germany (Gerlach and Musolf 2000).

California tiger salamander mortality and injury occurs when the animals attempt to cross roads and are hit by cars, trucks, or motorcycles. The majority of strikes occur on rainy nights when the animals are moving to their breeding ponds. Thus, vehicle strikes are a direct source of mortality for the California tiger salamander. If vehicle strikes are sufficiently frequent in a given locality, this could result in reduced abundance of this animal. Especially problematic is the death of females prior to the laying of their eggs because this could result in the loss of an entire cohort, and therefore, reduced recruitment of new individuals into the population.

Vehicles constitute a consistent source of mortality for the animal, based on the frequency with which vehicle strikes occur. Although no systematic, range-wide studies have been conducted, it is known that significant numbers of California tiger salamanders are killed by vehicular traffic while crossing roads (Hansen and Tremper 1993; S. Sweet, *in litt.* 1993; Joe Medeiros, Sierra College, pers. comm. 1993). For example, during a 1-hour period on a road bordering Lake Lagunita on the Stanford University campus, 45 California tiger salamanders were collected, 28 of which had been killed by cars (Twitty 1941). More recently, during one 15-day period in 2001 at a Sonoma County location, 26 road-killed California tiger salamanders were found (D. Cook, pers. comm. 2002). Overall breeding population losses of California tiger salamanders due to road kills have been estimated to be between 25 and 72 percent (Twitty 1941; S. Sweet *in litt.* 1993; Launer and Fee *in litt.* 1996). Mortality may be increased by associated roadway curbs and berms as low as 3.5 to 5 inches, which allow California tiger salamanders access to roadways but prevent their exit from them (Launer and Fee 1996; S. Sweet *in litt.* 1998).

California Red-legged Frog

Individual red-legged frogs may be directly injured, killed, harmed, and harassed by activities that disturb breeding, dispersal, and aestivation habitat. The proposed project would (1) result in the permanent loss of approximately 1.4 acres and the temporary loss of 3 acres of red-legged frog habitat; (2) result in the death of an unknown number of red-legged frogs; (3) result in construction related harassment, including effects from lights used during nighttime activities, to the surviving red-legged frogs on the site; (4) impede the dispersal of red-legged frogs through the site while the action is in progress; (5) increase the likelihood of predation; (6) fragment and reduce the amount of red-legged frog habitat in Alameda County.

Changes in light level may disrupt orientation in nocturnal animals. The range of anatomical adaptations to allow night vision is broad (Park 1940), and rapid increases in light can blind animals. For frogs, a quick increase in illumination causes a reduction in visual capability from which the recovery time may be minutes to hours (Buchanan 1993). After becoming adjusted to a light, frogs may be attracted to it as well (Jaeger and Hailman 1973). Laboratory experiments have demonstrated that dark-adapted frog species exposed to rapid increases in illumination may be temporarily "blinded" and unable to gather visual information on prey, predators, or conspecifics until their eyes adapt to the new illumination. Foraging may be facilitated in frog species that hunt around lights because the ambient illumination is increased to a level that allows the frogs to see prey or because lights attract abnormally large numbers of insects and other invertebrate prey. Experiments and anecdotal evidence indicates that both temporary and permanent changes to the night time illumination of an area may affect the reproduction, foraging, predator avoidance, and social interactions of frog species (Buchanan 2002). Reproductive behaviors may be altered by artificial lighting; it may be inhibited in frog species that normally reproduce only at very low illuminations. Female frogs of the species *Physalaemus pustulosus* are less selective about mate choice when light levels are increased, evidently preferring to mate quickly and avoid the increased predation risk of mating activity (Rand *et al.* 1997). Longcore and Rich (2002) reported that frogs in an experimental enclosure stopped mating activity during night football games, when lights from a nearby stadium increased sky glow. Mating choruses only resumes when the enclosure was covered to shield the frogs from light.Increased illumination may allow predators to see frogs that may not normally be visible to them. Circadian rhythms, activity patterns, and intraspecific visual communication also may be affected by increased illuminations.

Breeding habitat, identified as Site 1, will be eliminated by the proposed project. Individual frogs occupying the affected habitat run the risk of being crushed or buried by earth moving activities. Those that do survive will suffer permanent and temporary loss of habitat, and harassment from increased human activity. Construction of an unspecified duration and location will occur at night and the associated lighting may increase predation because frogs will lose the cover of darkness. In addition to the elimination of the breeding pond identified as Site 1, at certain times during construction the movement of frogs from breeding ponds north of State Route 84 to summer habitat south of State Route 84, and visa versa, likely will be impeded by construction activities. Temporary loss of dispersal habitat for the project duration increases

The potential adverse effects of the proposed Pigeon Pass Project include habitat fragmentation; altered hydrology; non-point source pollution; dust emissions; erosion; sedimentation; hazardous material spills; human disturbance; and establishment of invasive nonnative plants. The project could potentially result in habitat fragmentation. The results of fragmentation are inhibition of genetic exchange between populations and impediments to recolonization of habitats from which populations have been extirpated. Small, isolated populations are substantially more vulnerable to stochastic events (e.g., aberrant weather patterns, fluctuations in availability of food) and may exhibit reduced adaptability to environmental (natural or anthropogenic) changes.

The Service considers all vernal pool branchiopods and their habitat not considered to be directly affected but within 250 feet of proposed construction activities to be indirectly affected by project implementation. Habitat indirectly affected includes all habitat supported by future destroyed areas and swales, and all habitat otherwise damaged by loss of watershed, human intrusion, introduced species, and pollution that will be caused by the proposed project. The proposed project will directly affect 0.61 acre and 0.2 ace of vernal pool will be indirectly affected by the proposed project. The new alignment will affected the vernal pool fairy shrimp through construction activities and long-term effects occurring within 250 feet of it. Individual branchiopods and their cysts, which may inhabit this seasonal wetland, may be injured or killed by any of the following indirect effects:

*Erosion* - The ground disturbing activities in the watershed of vernal pools associated with the proposed project action area are expected to result in siltation when pools fill during the wet season following construction. Siltation in pools supporting vernal pool fairy shrimp may result in decreased cyst viability, decreased hatching success, and decreased survivorship among early life history stages, thereby reducing the number of mature adults in future wet seasons. The proposed project construction activities could result in increased sedimentation transport into vernal pool branchiopod habitats during periods of heavy rains.

*Changes in hydrology* - The biota of vernal pools and swales can change when the hydrologic regime is altered (Bauder 1986, 1987). Survival of aquatic organisms like the vernal pool fairy shrimp are directly linked to the water regime of their habitat (Zedler 1987). Therefore, construction near vernal pool areas will, at times, result in the decline of local sub-populations of vernal pool organisms, including fairy shrimp.

*Introduction of non-natives* - There is an increased risk of introducing weedy, non-native plants into the vernal pools both during and after project construction due to the soil disturbance from clearing and grubbing operations, and general vegetation disturbance associated with the use of heavy equipment.

*Chemical contamination* - The runoff from chemical contamination can kill listed species by poisoning. Oils and other hazardous materials associated with construction equipment could be conveyed into the habitat of the vernal pool fairy shrimp by overland runoff during the rainy season, thereby adversely affected water quality. Many of these chemical compounds are thought to have adverse affects on this species. Individuals may be killed directly or suffer reduced

## CONCLUSION

After reviewing the current status of the vernal pool fairy shrimp, California tiger salamander, California red-legged frog, and the San Joaquin kit fox, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the Pigeon Pass Project is not likely to jeopardize the continued existence of these four listed species. Critical habitat for the San Joaquin kit fox has not been proposed or designated, therefore, none will be affected by the proposed project. Critical habitat for the vernal pool fairy has been designated, however none is located in the action area, and therefore none will be affected by the proposed project. Critical habitat has been proposed for the California tiger and the California red-legged frog, however none will be adversely modified or destroyed. The Service reached the conclusion on the effects on the proposed critical habitat of the California red-legged frog and the California tiger salamander because the effects of the project will be offset by the conservation measures in the project description, including the successful restoration of areas subject to the temporary effects of cut and fill to pre-project conditions.

## INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the California Department of Transportation so they become binding conditions of project authorization for the exemption under 7(o)(2) to apply. The California Department of Transportation has a continuing duty to regulate the activity that is covered by this incidental take statement. If the California Department of Transportation (1) fails to adhere to the terms and conditions of the incidental take statement through enforceable terms, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of 7(o)(2) may lapse.

### Amount or Extent of Take

The Service expects that incidental take of the San Joaquin kit fox will be difficult to detect or quantify because when this mammal is not foraging, mating, or conducting other surface activity, The Service anticipates that incidental take of the vernal pool fairy shrimp will be difficult to detect because when this crustacean is not in its active adult stage, the cysts or napulai are difficult to located in the vernal pools and seasonal wetlands; and the finding of an injured or dead individual is unlikely because of their relatively small body size. Losses of this species also may be difficult to quantify due to seasonal fluctuations in their numbers, random environmental events, changes in water regime at their breeding ponds, or additional environmental disturbances. Therefore, the Service is estimating that all vernal pool fairy shrimp inhabiting 0.84 acres of vernal pools and seasonal wetlands as delineated in the biological assessment and based on the November 8, 2004, site visit, will be subject to incidental take. Upon implementation of the Reasonable and Prudent Measures, incidental take associated with the Pigeon Pass Project in the form of harm, harassment, injury, and death of the vernal pool fairy shrimp caused by habitat loss and construction activities will become exempt from the prohibitions described under section 9 of the Act.

**Effect of the Take**

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the San Joaquin kit fox, California red-legged frog, California tiger salamander. Critical habitat for the San Joaquin kit fox has not been proposed or designated, therefore, none will be affected by the proposed project. Critical habitat for the vernal pool fairy has been designated, however none is located in the action area, and therefore will not be affected by the proposed project. Critical habitat has been proposed for the California tiger and the California red-legged frog, however none will be adversely modified or destroyed based on the proposed restoration of the areas subject to temporary disturbance.

**Reasonable and Prudent Measures**

The following reasonable and prudent measures are necessary and appropriate to minimize the effects of the Pigeon Pass Project on the San Joaquin kit fox, California tiger salamander, California red-legged frog, and the vernal pool fairy shrimp:

1. The California Department of Transportation shall implement conservation measures for the San Joaquin kit fox, California red-legged frog, California tiger salamander, and the vernal pool fairy shrimp to minimize (1) the effects of the loss of habitat that will occur as a result of the project; (2) the potential for harassment, harm, injury, and mortality to these four listed species; and (3) the potential for inadvertent capture or entrapment of federally listed wildlife species during construction activities.

2. The California Department of Transportation shall ensure their compliance with this biological opinion.

**Terms and Conditions**

In order to be exempt from the prohibitions of section 9 of the Act, the Federal Highway Administration shall ensure the California Department of Transportation complies with the

If biologist/construction liaison has requested a stop work due to take of any of the listed species the Service and Fish and Game will be notified within one (1) working day via email or telephone

6. Permanent and temporary construction disturbances and other types of project-related disturbance to San Joaquin kit fox, California red-legged frog, California tiger salamander, and the vernal pool fairy shrimp habitat shall be minimized to the maximum extent practicable. To minimize temporary disturbances, all project-related vehicle traffic shall be restricted to established roads, construction areas, and other designated areas. These areas also should be included in preconstruction surveys and, to the maximum extent possible, should be established in locations disturbed by previous activities to prevent further adverse effects.

7. Project employees shall be directed to exercise caution when commuting within the habitats of the California tiger salamander, California red-legged frog, and the San Joaquin kit fox. A 20-mile per hour speed limit will be strongly encouraged on unpaved roads within listed species habitats.

8. Cross-country travel by vehicles shall be prohibited, unless authorized by the Service.

9. Project employees shall be provided with written guidance governing vehicle use, speed limits on unpaved roads, fire prevention, and other hazards.

10. Prior to initiation of ground breaking, the California Department of Transportation of or Service-approved biologist will conduct an education and training session for all construction personnel. All individuals who will be involved in the site preparation or construction shall be present, including the project representative(s) responsible for reporting take to the Service and the California Department of Fish and Game. Training sessions shall be repeated for all new employees before they access the project site. Sign up sheets identifying attendees and the contractor/company they represent shall be provided to the Service with the post-construction compliance report. At a minimum, the training shall include a description of the natural history of the San Joaquin kit fox, California tiger salamander, California red-legged frog, and the vernal pool fairy shrimp affected by the Pigeon Pass Project and include information on these four listed species and their habitats, as appropriate. The training shall include the general measures that are being implemented to conserve these species as they relate to the project, the penalties for non-compliance, and the boundaries (work area) of the project. To ensure that employees and contractors understand their roles and responsibilities, training shall be conducted in languages other than English, as appropriate.

prevent encroachment of construction personnel and equipment onto any sensitive areas during project work activities. Such fencing shall be inspected and maintained daily until completion of the project. The fencing will be removed only when all construction equipment is removed from the site. Actions within the project area shall be limited to vehicle and equipment operation on existing roads. No project activities will occur outside the delineated project construction area.

18. Prior to any ground disturbance, pre-construction surveys shall be conducted for San Joaquin kit fox, California tiger salamander, and the California red-legged frog. These surveys shall consist of walking surveys of the project limits and adjacent areas accessible to the public to determine presence of the species (i.e., kit fox dens and related sign).

19. Only California Department of Transportation biologist(s) who are familiar with the biology and ecology of the San Joaquin kit fox, California tiger salamander, or the California red-legged frog, or a Service-approved biologist holding valid permit issued pursuant to section 10(a)(1)(A) of the Act will be allowed to capture listed species.

20. Because dusk and dawn are often the times when San Joaquin kit fox, California red-legged frog, and the California tiger salamander are most actively foraging and dispersing, all construction activities should cease one half hour before sunset and should not begin prior to one half hour before sunrise. Except when necessary for necessary construction, driver or pedestrian safety, lighting of the Pigeon Pass Project site by artificial lighting during night time hours should be minimized to the maximum extent practicable.

21. Maintenance and construction excavations greater than two (2) feet deep either shall be covered or filled in at the end of each working day. Wooden ramps or other structures of suitable surface that provide adequate footing for the San Joaquin kit fox shall be placed in the trench or pit no greater than 200 feet apart to allow for unaided escape. The trench or pit shall be surveyed in the morning and late afternoon hours to ascertain whether the San Joaquin kit fox, California red-legged frog, and the California tiger salamander have fallen into the trench or pit. If at anytime, a trapped San Joaquin kit fox is discovered, the California Department of Transportation biologist shall immediately place escape ramps or other appropriate structures to allow the animal to escape, or the Service and/or the California Department of Fish and Game contacted for further guidance. If a California red-legged frog or California tiger salamander is discovered trapped in a trench or pit, the animal shall be carefully captured by the California Department of Transportation biologist and released at a secure location, such as the entrance to a ground squirrel burrow, within walking distance and is outside of the construction area. The Service shall be notified by telephone and electronic mail within one (1) working day of the incident.

c. If a borrow site that is in compliance with the Act is not available, the California Department of Transportation shall either:

i. identify/select a site that the Service has concurred with the "no effect" determination, or;

ii. request reinitiation of formal consultation on the action considered herein based on new information.

25. The California Department of Transportation shall implement the following six general conservation measures for the San Joaquin kit fox:

a. The presence/absence of San Joaquin kit fox dens (natural or in pipes and culverts) shall be determined.

i. Pre-construction surveys within the project area shall be conducted no more than thirty (30) calendar days prior to the start of construction in accordance with the most current protocols approved by the Service and the California Department of Fish and Game.

ii. Surveys for dens shall be conducted by qualified biologists with demonstrated experience in identifying San Joaquin kit fox dens.

iii. Pipes and culverts shall be searched for kit foxes prior to being moved or sealed to ensure that a San Joaquin kit fox has not been trapped.

b. All San Joaquin kit fox dens shall be protected to the maximum extent practicable as determined by the on-site biologist in consultation with the Service.

c. The type of den (natal or non-natal) and its status (occupied or unoccupied) shall be identified based on the most current Service guidance (U.S. Fish and Wildlife Service 1999):

i. Known den: any existing natural den or human-made structure for which conclusive evidence or circumstantial evidence can show that the den is used or has been used at any time in the past by the San Joaquin kit fox.

ii. Potential den: any natural den or burrow within the range of the species that has entrances of appropriate dimensions (4 to 12 inches in diameter) to accommodate San Joaquin kit foxes. The California Department of Transportation shall survey and investigate using photo-detection equipment, track plate, or other

h. If an unoccupied natural San Joaquin kit fox den cannot be avoided and must be destroyed, the following actions shall be followed:

i. Prior to the destruction of any den, the den shall be monitored for at least three (3 ) consecutive days to determine its current status. Activity at the den shall be monitored by placing tracking medium at the entrance and by standard spotlighting detection techniques. If no San Joaquin kit fox activity is observed during this period, the den shall be destroyed immediately to preclude subsequent use. If San Joaquin kit fox activity is observed at the den during this period, the den shall be monitored for at least five (5) consecutive days from the time of observation to allow any resident animal to move to another den during its normal activities. Use of the den can be discouraged during this period by partially plugging the entrance(s) with soil in such a manner that any resident animal can escape easily. Destruction of the den may begin when, in the judgment of a Service or Service-approved biologist, the animal has moved to a different den. The biologist shall be trained and familiar with San Joaquin kit fox biology. If the animal is still present after five or more consecutive days of plugging and monitoring, the den may be excavated when, in the judgment of the Service-approved biologist, it is temporarily vacant, for example during the animal's normal foraging activities.

ii. All San Joaquin kit dens shall be excavated by hand, by or under the supervision of, a Service-approved biologist.

iii. The den shall be fully excavated and then filled with dirt and compacted to ensure that San Joaquin kit foxes cannot reenter or use the den during the construction period. If, at any point during excavation a kit fox is discovered inside the den, the excavation activity shall cease immediately and monitoring of the den shall be resumed. Destruction of the den may be resumed, when in the judgment of the Service-approved biologist, the animal has escaped from the partially destroyed den.

iv. Non-natal San Joaquin kit dens may be excavated at any time of the year; natal dens shall be excavated only between August 15 and November 1.

B. The following Terms and Conditions implement Reasonable and Prudent Measure two (2):

1. If requested, during or upon completion of construction activities, the on-site biologist, and/or a representative from California Department of Transportation shall accompany Service or California Department of Fish and Game personnel on

of any conservation recommendations. We propose the following conservation recommendations:

1. The California Department of Transportation should assist the Service in implementing recovery actions identified in the *Recovery Plan for the California red-legged Frog* (U.S. Fish and Wildlife Service 2002).

2. The California Department of Transportation should assist the Service in developing and implementing recovery actions identified in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (U.S. Fish and Wildlife Service 1998).

3. The California Department of Transportation should incorporate culverts, tunnels, or bridges on highways and other roadways that allow safe passage by California tiger salamanders, California red-legged frogs, San Joaquin kit foxes, other listed animals, and wildlife. The California Department of Transportation should include photographs, plans, andother information in their biological assessments if they incorporate "wildlife friendly" crossings into their projects.

4. The Federal Highway Administration and the California Department of Transportation should consider participating in the planning for a regional habitat conservation plan for the San Joaquin kit fox, California tiger salamander, other listed species, and sensitive species.

5. The California Department of Transportation should consider establishing functioning preservation and creation conservation banking systems to further the conservation of the California tiger salamander, San Joaquin kit fox, listed crustacean species, and other appropriate species. Such banking systems also could possibly be utilized for other required mitigation (i.e., seasonal wetlands, riparian habitats, etc.) where appropriate.

6. Sightings of any listed or sensitive animal species should be reported to the California Natural Diversity Database of the California Department of Fish and Game. A copy of the reporting form and a topographic map clearly marked with the location the animals were observed also should be provided to the Service.

7. The California Department of Transportation should provide habitat for bats, including surfaces for bat roosts on the underside of bridges and other structures whenever possible.

## REINITIATION - CLOSING STATEMENT

This concludes the conference for effects of the proposed addition of truck climbing lanes and curve corrections to State Route 84 (Pigeon Pass Project) in Alameda County, California, on the critical habitats for the California red-legged frog and California tiger salamander. You may ask the Service to confirm the conference opinion as a biological opinion issued through formal consultation if either of these critical habitats are designated. The request must be in writing. If the Service reviews the proposed action and finds that there have been no significant changes in

LITERATURE CITED

Anderson, J. D. 1968. Comparison of the food habits of *Ambystoma macrodactylum sigillatum*, *Ambystoma macrodactylum croceum*, and *Ambystoma tigrinum californiense*. Herpetologica 24(4): 273-284.

Anderson, P. R. 1968. The reproductive and developmental history of the California tiger salamander. Masters thesis, Department of Biology, Fresno State College, Fresno, California. 82pp.

Anderson, R.L., L.K. Spiegel, and K.M. Kakiba-Russell. 1991. Southern San Joaquin Valley ecosystems protection program: natural lands inventory and maps. California Energy Commission, Sacramento, California 41 pp. + maps.

Aubrey, K.B., G.M. Koehler, and J. R. Squires. 1999. Ecology of Canada lynx in southern boreal forests. *In* L.F. Ruggiero, K.B. Aubrey, S.W. Buskirk, G. Koehler, C. Krebs, K. McKelvey, and J. Squires (eds.). The scientific basis for lynx conservation. General Technical Report RMRS-GTR-30, U.S.D.A. Forest Service, Ogden, Utah.

Barbour, M.G. and Major, J. 1988. Terrestrial vegetation of California. California Native Plant Society, Sacramento, California.

Barnum, S. 1999. A programmatic agreement to minimize highway project impacts on Canada lynx (*Lynx canadensis*) in Colorado. Pages 67-74 *in* G.L. Evink, P. Garrett, and D. Ziegler (eds.). Proceedings of the third international conference on wildlife ecology and transportation. FL-ER-73-99. Florida Department of Transportation, Tallahassee, Florida.

Barrett, L. 1990. Annual review of animal rabies in California. 1989. California Vet. 44:52-54.

Barry, S. J. and H. B. Shaffer. 1994. The status of the California tiger salamander (*Ambystoma californiense*) at Lagunita: A 50-year update. Journal of Herpetology 28(2): 159-164.

Beedy, E. C., V. K. Getz, and D. A. Airola. 1992. Status of the San Joaquin Kit Fox *Vulpes macrotis mutica* in the urban Kern River Parkway, Bakersfield, California. Pages 47-53 *in* D. F. Williams, S. Byrne, and T. A. Rado (eds.) Endangered and sensitive species of the San Joaquin Valley, California: their biology, management, and conservation. California Energy Commission, Sacramento, California.

Beier, P. 1993. Determining minimum habitat areas and habitat corridors for cougars. Conservation Biology 7:940-108.

Bell, H. M. 1994. Analysis of habitat characteristics of the San Joaquin kit fox in its northern range. Master of Arts thesis, California State University, Hayward, California. 90 pp.

Bennett, A.F. 1991. Roads, roadsides, and wildlife conservation: a review. Pages 99-108 *in* D. A. Saunders and R. J. Hobbs (eds.). Nature conservation: the role of corridors. Surrey Beatty ad Sons, Melbourne, Australia.

Benfenati, E., S. Valzacchi, G. Maniani, L. Airoldi, and R. Farnelli. 1992. PCDD, PCDF, PCB, PAH, cadmium, and lead in roadside soil: relationship between road distance and concentration. Chemosphere 24:1077-1083.

Berry, W. H., W. G. Standley, T. P. O'Farrell, and T. T. Kato. 1992. Effects of military-authorized activities on the San Joaquin kit fox (*Vulpes velox macrotis*) at Camp Roberts Army National Guard Training Site, California. U. S. Department of Energy Topical Report No. EGG 10617-2159, EG&G/EM Santa Barbara Operations, National Technical Information Service, Springfield, Virginia

Carbyn, L.N., H.J. Armbuster, and C. Mamo. 1994. The swift fox reintroduction program in Canada from 1983 to 1992. Pages 247-270 *in* M.L. Bowles and C.J. Whelan (eds.). Restoration of endangered species: conceptual issues, planning and implemenation. Cambridge University Press, Cambridge, Great Britain

Castillo-Sanchez, C. 1999. Highways and wildlife conservation in Mexico: the Sonoran pronghorn at El Pinacate y Gran Desierto de Altar Biosphere Reserve on the Mexico-USA border. Pages 289-292 *in* G.L. Evink, P. Garrett, and D. Ziegler (eds.). Proceedings of the third international conference on wildlife ecology and transportation. FL-ER-73-99. Florida Department of Transporation. Tallahassee, Florida.

Caughley, G., and Gunn, A. 1993. Dynamics of large herbivores in deserts: kangaroos and caribou. Oikos 67: 47-55.

Clevenger, A. P., M. McIvor, D. McIvor, B. Chruszcz, K. Gunson 2001. Tiger Salamander, *Ambystoma tigrinum*, Movements and Mortality on the Trans-Canada Highway in Southwestern Alberta. Canadian Field Naturalist 115: 199-204.

Clevenger, A.P. and N. Waltho. 1999. Dry culvert use and design considerations for small- and medium-sized mammal movement across a major transportation corridor. Pages 263-178 *in* G. L. Evink, P. Garrett, and D. Zeigler, eds. Proceedings of the third international conference on wildlife ecology and transportaion. FL-ER-73-99, Florida Department of Transportation. Tallahassee, Florida.

Coe, T. 1988. The application of Section 404 of the Clean Water Act to vernal pools. Pages 356-358 *in* J.A. Kusler, S. Daly, and G. Brooks (eds.). Urban Wetlands. Proceedings of the National Wetland Symposium. Oakland, California.

Cornman, David. 2001. Effects of Noise on Wildlife. Nature Sound Society. San Francisco State University, San Francisco, California

Covell, D.F. 1992. Ecology of the swift fox (*Vulpes velox*) in southeaqstern Colorado. Master of Science thesis, University of Wisconsin, Madison, Wisconsin.

Cypher, B. L. 2000. Effects of roads on San Joaquin kit foxes: a review and synthesis of existing data. Endangered Species Recovery Program, California State University, Fresno, California.

Cypher, B.L., G.D. Warrick, M.R.M. Otten, T.P.O'Farrell, W.H. Berry, E.C. Harris, T.T. Kato, P.M. McCue, J.H. Scrivner, and B.W. Zoellick. 2000. Population dynamics of San Joaquin kit foxes at the Naval Petroleum Reserve in California. Wildlife Monographs 145.

Cypher, B. L., and Scrivner, J. H. 1992. Coyote control to protect endangered San Joaquin kit foxes at the Naval Petroleum Reserves, California. Pages 42-47 *in* J.E. Borrecco and R E. Marsh (eds.). Proceedings of the 15th Vertebrate Pest Conference, March 1992, Newport Beach, Calif. University of California, Davis, California.

Cypher, B. L., and Spencer, K. A. 1998. Competitive interactions between coyotes and San Joaquin kit foxes. Journal of Mammalogy 79: 204-214

Dalrymple, G.H., and N.G. Reichenbach. 1984. Management of an endangered species of snake in Ohio, USA. Biological Conservation 30:195-200.

Disney, M., and Spiegel, L. K. 1992. Sources and rates of San Joaquin kit fox mortality in western Kern County, California. Trans. West. Sec. Wildl. Soc. 28: 73-82.

Donald, D.B. 1983. Erratic occurrence of anostracans in a temporary pond: colonization and extinction or adaptation to variations in annual weather? Can. J. Zool. 61:1492-1498

Gilpin, M. E. 1987. Spatial structure and population vulnerability. Pages 125-139 *in* M. E. Soule (ed.). Viable populations for conservation. Cambridge University Press, New York, New York.

Gilpin, M. E. and M. E. Soule. 1986. Conservation Biology. Minimum viable populations: Processes of species extinction. Sinauer Associates, Sunderland, Massachusetts.

_____ 1988. Minimum viable populations: processes of species extinction. Pages 18-34 *in* E.E. Soule, (ed.). Conservation Biology: The Science of Scarcity and Diversity. Sinauer Associates, Sunderland, Massachusetts.

Goodman, D. 1987a. The demography of chance extinction. Pages 11-19 *in* M. E. Soule (ed.). Conservation biology: the science of scarcity and diversity. Sinauer Associates, Inc. Sunderland, Massachusetts.

Goodman, D. 1987b. How do any species persist? Lessons for conservation biology. Conservation Biology 1:59-62.

Gilpin, M. E. and M. E. Soule. 1986. Conservation Biology. Minimum viable populations: Processes of species extinction. Sinauer Associates, Sunderland, Massachusetts.

_____1988. Minimum viable populations: processes of species extinction. Pages 18-34 *in* E.E. Soule, (ed.). Conservation Biology: The Science of Scarcity and Diversity. Sinauer Associates, Sunderland, Massachusetts.

Goodman, D. 1987a. The demography of chance extinction. Pages 11-19 *in* M. E. Soule (ed.). Conservation Biology: The Science of Scarcity and Diversity. Sinauer Associates, Sunderland, Masschusetts.

______1987b. How do any species persist? Lessons for conservation biology. Conservation Biology 1:59-62.

Grigione, M.M. 2002. Turning night into day: the artificial effects of artificial night lighting on endangered and other mammal species. Paper presented at the Urban Wildlands Group's Ecological Consequences of Artificial Night Lighting. February 23-24, 2002. University of California, Los Angeles, California.

Grinnell, J., J.S. Dixon, and J.M. Linsdale. 1937. Fur-bearing mammals of California. Volume 2. University of California Press. Berkeley, California.

Hall, E.R. 1981. The Mammals of North America. Second ed. John Wiley and Sons, New York,

Hall, H. M. 1983. Status of the kit fox at the Bethany wind turbine generating (WTC) project site, Alameda County, California. California Department of Fish and Game, Sacramento, California.

Harvey, H.T. and Associates. (1997). Santa Clara Valley Water District: California red-legged frog distribution and status-1997. Project No. 1164-01.

Hayes, M.P. and M.R. Jennings. 1988. Habitat correlates of distribution of the California red-legged frog (*Rana aurora draytonii*) and the foothill yellow-legged frog (*Rana boylii*): Implications for management. Pages 144-158 *in* R. Sarzo, K. E. Severson, and D. R. Patton (technical coordinators). Proceedings of the Symposium on the Management of Amphibians, Reptiles, and Small Mammals in North America. U.S.D.A. Forest Service General Technical Report RM-166.

Hayes, M.P. and D.M. Krempels. 1986. Vocal sac variation among frogs of the genus *Rana* from western North America. Copeia 1986(4):927-936.

Hayes, M.P. and M.M. Miyamoto. 1984. Biochemical, behavioral and body size differences between *Rana aurora aurora* and *R. a. draytonii*. Copeia 1984(4):1018-1022.

series volume 18. United Nations Educational, Scientific, and Cultural Organization, Paris, France.

Jones and Stokes Associates. 1989 Draft Environmental Impact Report: Vasco Road and Utility Relocation Project SCH#: 890321123. Prepared for Contra Costa Water District, Concord, California.

Kamler, J.F., W.B. Ballard, E.B. Fish, P.R.Lemons, K. Mote, and C.C. Perchellet. 2003. Habitat use, home ranges, and survival of swift foxes in a fragmented landscape: conservation implications. Journal of Mammalogy 84(3):989-995.

Keeler-Wolf, T., D. R. Elam, and S. A. Flint. 1995. California vernal pool assessment, preliminary report. Discussion draft # 2. California Department of Fish and Game, Sacramento, California.

Keeley, J. E. and P. H. Zedler. 1998. Characterization and global distribution of vernal pools. Pages 1-14 *in* E C. W. Witham, E. T. Bauder, D. Belk, W. R. Ferren Jr. and R. Ornduff (eds.). Ecology, conservation, and management of vernal pool ecosystems - proceedings from a 1996 Conference. California Native Plant Society, Sacramento, California.

Kitchen, A.M. E.M. Gese, and E.R. Schauster. 1999. Resource partitioning between coyotes and swift foxes: space, time, and diet. Canadian Journal of Zoology 77:1645-1656.

Knapp, D.K. 1978. Effects of agricultural development in Kern County, California, on the San Joaquin kit fox in 1977. California Department of Fish and Game. Non-Game Wildlife Investigations Final Report Project E-1-1, Jov V-1.21.

Komanoff, C. and H. Shaw. 2000. Drowning in Noise: Noise costs of jet skis in America. The Noise Pollution Clearinghouse. Montpelier, Vermont.

Koopman, M.E. 1995. Food habits, space use, and movements of the San Joaquin kit fox on the Elk Hills Naval Petroleum Reserves in California. M.S. thesis, University of California, Berkeley, California. 41 pp.

Koopman, M.E., B.L. Cypher, and J.H. Scrivner. 2000. Dispersal patterns of San Joaquin kit foxes (*Vulpes macrotis mutica*). Journal of Mammalogy 81(1):213-222.

Koopman, M.E., J.H. Scrivner, and T.T. Kato. 1998. Patterns of den use by San Joaquin kit foxes. Journal of Wildlife Management 62:373-379.

Kondolf, G. Mathias, R. Kattelmann, M. Embury, and D. C. Erman. 1996. Status of Riparian Habitat *in* Don C. Erman (ed). Status of the Sierra Nevada. Sierra Nevada Ecosystem Project Final Report to Congress. University of California, Davis, California.

Krapu, G. L. 1974. Foods of breeding pintails in North Dakota. Journal of Wildlife Management. 38(3): 408-417.

Kushlan, J.A. 1988. Conservation and management of the American crocodile. Environmental Management 12:777-790.

Lande, R. 1988. Genetics and Demography in Biological Conservation. Science 241:1455-1460.

_____ 1999. Extinction risks from anthropogenic, ecological, and genetic factors. Pages 1-22 *in* L. Landweber and A. Dobson (eds.). Genetics and the Extinction of Species: Cambridge Univ. Press. Cambridge, England.

Laughrin, L. 1970. San Joaquin kit fox, its distribution and abundance. California Department of Fish and Game, Wildlife Management Branch Administrative Report 70-2. Sacramento, California.

Morrell, S. H. 1970. Life history study of the San Joaquin kit fox. California Department of Fish and Game, Federal Aid in Wildlife Restoration project W-54R-2. Sacramento, California.

____ 1972. Life History of the San Joaquin kit fox. California Fish and Game 58:162-174.

____ 1975. San Joaquin kit fox distribution and abundance in 1975. California Dept. Fish and Game, Sacramento, California. Wildl. Manage. Branch, Admin. Rep. No. 75-3, 28 pp.

Mumme, R.L., S.J. Schoech, G.E. Woolfenden, and J.W. Fitzpatrick. 1999. Life and death in the fast lane: demographic consequences of road mortality in the Florida scrub jay. Conservation Biology 14:501-512.

Murdoch, J.D., K. Ralls, and B, Cypher. 2005. Two observations of tree climbing by the San Joaquin kit fox. Southwest Naturalist 49:522-525.

National Institutes of Health, 1990. Noise and hearing Loss, NIH Consensus Statement Online 1990 Jan 22-24;8(1):1-24.

National Park Service (NPS). 1994. Report on effects of aircraft overflights on the National Park System. Report to Congress. Technical Report No. NPSD1062. Washington, D.C.

Natural Resources Conservation Service. 2000. Summary Report 1997 National Resources Inventory. Iowa State University. United States Department of Agriculture.

Nikiforoff, C. C. 1941. Hardpan and microrelief in certain soil complexes of California. Washington, D.C. United States Department of Agriculture: 45.

Ng, S.J., J.W. Doyle, R.M. Sauvajot, S.P.D. Riley, and T. Valone. 2004. Use of highway undercrossings by wildlife in southern California. Biol. Conservation 115:499-507.

O'Neal, G.T., J.T. Flinders, and W.P. Clary. 1987. Behavioral ecology of the Nevada kit fox (*Vulpes macrotis nevadensis*) on a managed desert rangeland. Pages 443-481 *in* H.H. Genoways (ed.). Current Mammalogy volume I. Plenum Press, New York, New York.

Orloff, S.G., F. Hall and L. Spiegel. 1986 Distribution and habitat requirements of the San Joaquin kit fox in the northern extreme of their range. Trans. West. Sect. Wildl. Soc. 22:60-70.

Oxley, D.J., M.B. Fenton, and G.R. Carmody. 1974. The effects of roads on populations of small mammals. Journal of Applied Ecology 11:51-59.

Park, O. 1940. Nocturnalism – the development of a problem. Ecological Monographs 10:485-536.

Paveglio, F. L. and S. D. Clifton. 1988. Selenium accumulation by San Joaquin kit foxes and coyotes in the Kesterson National Wildlife Refuge Area-draft. U.S. Fish and Wildlife Service. Los Banos, Calfornia. Unpubl. Rep. 59 pp.

Pechmann, J. H. K., D. E. Scott, J. W. Gibbons, and R. D. Semlitsch. 1989. Influence of wetland hydroperiod on diversity and abundance of metamorphosing juvenile amphibians. Wetlands Ecology and Management 1(1):3-11.

Peters, E.N. 1965. Temporary shifts in auditory thresholds of chinchilla after exposure to noise. J. Acoustical Soc. Am. 37:831-833.

Petranka, J. W. 1998. Salamanders of the United States and Canada. Sminthsonian Instituion Press, Washington, D.C.

Ralls, K., K.L. Pilrim, P.J. White, E. Paxinos, M. Schwartz, and R. Fleischer. 2001. Kinship, social relationships, and den sharing in kit foxes. J. Mammalogy 82(3): 858-866.

Ralls, K. and P.J. White. 1995. Predation on San Joaquin kit foxes by larger canids. Journal of Mammalogy 76:723-729.

prepared by the Coyote Creek Riparian Station for the U.S. Fish and Wildlife Service, Sacramento Office, Sacramento, California. 33 pp.

Shaffer, H.B., G. B. Pauly, J.C. Oliver, and P.C. Trenham. 2004. The molecular phylogenitics of endangerment: cryptic variation and historic phylogeography of the California tiger salamander, *Ambystoma califoriniense*. Molecular Ecology 13: 3033-3049.

Shaffer, H. B., R. N. Fisher, and S. E. Stanley. 1993. Status report: the California tiger salamander (*Ambystoma californiense*). Final report for the California Department of Fish and Game.

Shaffer, M. 1987. Minimum viable populations: coping with uncertainty. Pages 69-86 *in* M. E. Soule (ed.). Viable populations for conservation. Cambridge University Press, New York, New York.

Shaffer, M.L. 1981. Minimum population sizes for species conservation. BioScience 31:131-134.

Shaw, E.W. 1970. California Condor. Library of Congress Legislative Reference Service, SK351, p. 70-127.

Simovich, M., R. Brusca, and J. King. 1992. Invertebrate survey 1991-1993 PGT-PGE/Bechtel pipeline expansion project. University of San Diego, Alcala Park, San Diego, California.

Smith, F. 1977. A short review of the status of riparian forests in California. Pages 1-2 *in* Riparian Forests in California: Their Ecology and Conservation. Institute of Ecology Publication No. 15, Davis, California.

Soule, M. 1990. The Onslaught of Alien Species and Other Challenges in the Coming Decades. Conservation Biology 4:233-239

Sovada, M.A.., C.C. Roy, J.B. Bright, and J.R. Gillis. 1998. Causes and rates of mortality of swift foxes in western Kansas. Journal of Wildlife Management 62:1300-1306.

Spencer, K.A., W.H. Berry, W.G. Standley, and T.P. O'Farrell. 1992. Reproduction of the San Joaquin kit fox on Camp Roberts Army National Guard Training site, California. U.S. Department of Energy Topical Report EGG 10617-2154.

Spiegel, L.K. and M. Disney. 1996. Mortality sources and survival rates of San Joaquin kit foxes in oil-developed and undeveloped lands of southwestern Kern County, California

Spiegel, L.K. 1996. Studies of the San Joaquin kit fox in undeveloped and oil-developed areas. California Energy Commission Pub. No. P700-96-003. California Energy Commission Publication Unit, Sacramento, California.

Spiegel, L.K. and J. Tom. 1996. Reproduction of San Joaquin kit fox undeveloped and oil-developed habitats of Kern County, California. Pages 53-69 *in* L.K. Spiegel (ed.). Studies of the San Joaquin kit fox in undeveloped and oil-developed areas. California Energy Commission, Sacramento, California.

Standley, W. G., W. H. Berry, T. P. O'Farrell, and T. T. Kato. 1992. Mortality of San Joaquin kit fox (*Vulpes velox macrotis*) at Camp Roberts Army National Guard Training Site, California. U. S. Department of Energy Topical Report No. EGG 10617-2157, EG&G/EM Santa Barbara Operations, National Technical Information Service, Springfield, Virginia.

Stebbins, R.C. 1962. Amphibians of western North America. University of California Press. Berkeley, California.

U. S. Department of Energy. 1993. Petroleum production at maximum efficiency rate, Naval Petroleum Reserve number 1 (Elk Hills), Kern County, California: supplement to the 1979 final environmental impact statement. Naval Petroleum Reserve, Tupman, California.

U. S. Fish and Wildlife Service. 1967. Native Fish and Wildlife, Endangered Species. **Federal Register** 32: 4001.

_____ 1983. San Joaquin Kit Fox Recovery Plan. Sacramento, California

_____ 1985. Florida key deer recovery plan. Atlanta, Georgia.

_____ 1992. Wetland losses within northern California from projects authorized under Nationwide Permit No. 26. Sacramento Field Office, Sacramento, California.

_____ 1994*a*. Endangered and threatened wildlife and plants; determination of endangered status for the Conservancy fairy shrimp, longhorn fairy shrimp, and the vernal pool tadpole shrimp, and threatened status for the vernal pool fairy shrimp. **Federal Register** 59:48136-48153.

_____ 1994*b*. Endangered and threatened wildlife and plants; 12 Month Finding for the California Tiger Salamander. **Federal Register** 59:18353-18354.

_____ 1995 Endangered and threatened species; notice of reclassification of 32 candidate species. **Federal Register** 60: 34225-34227.

_____ 1996. Endangered and threatened wildlife and plants; determination of threatened status for the California Red-Legged Frog. **Federal Register** 61:25813-25833.

_____ 1998. Recovery Plan for Upland Species of the San Joaquin Valley, California. Portland, Oregon. 319pp.

_____ 2001*a*. Endangered and threatened wildlife and plants; final determinations of critical habitat for the California Red-legged Frog; Final Rule. **Federal Register** 66:14626-14758

_____ 2002. Recovery Plan for the California Red-legged Frog (*Rana aurora draytonii*). , Portland, Oregon. viii + 173 pp.

_____ 2003. Endangered and threatened wildlife and plants; habitat for four vernal pool crustaceans and eleven vernal pool plants in California and southern Oregon; Final Rule. **Federal Register** 68:46684-46867.

_____ 2004a. Endangered and threatened wildlife and plants; determination of threatened status for the California tiger salamander; and special rule exemption for existing routine ranching activities; final rule. **Federal Register** 69: 47212-47248. .

_____ 2004*b*. Endangered and threatened wildlife and plants; proposed designation of critical habitat for the California Tiger Salamander, Central Population; Proposed Rule. **Federal Register** 69:19620-19642.

_____ 2004*c*. Endangered and threatened wildlife and plants; proposed designation of critical habitat for the California Red-legged Frog (*Rana aurora draytonii*) Proposed Rule. **Federal Register** 69:19620-19642.

URS. 2003. Large branchiopod dry (2002) and wet (2002-2003) season surveys Caltrans SR 84 curve realignment project. Oakland, California.

Vanderbilt-White, C.A., and P.J. White. 1992. Population Status of the short-nosed kangaroo rat on the Carizzo Plain Natural Area, California. Trans. West. Sec. Wildl. Soc. 28:30-33.

Ecological Consequences of Artificial Night Lighting. February 23-24, 2002. University of California, Los Angeles, California.

Wright, A.H. and A.A. Wright. 1949. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Company, Inc., Ithaca, New York. xii + 640 pp.

Zeiner, D. C., W. Laudenslayer, and K. Mayer. 1988. Tiger salamander *Ambystoma tigrinum*. Pages 2-3 *in* Anonymous (ed). California 's Wildlife, Volume 1: Amphibians and Reptiles. California Department of Fish and Game, Sacramento, California.

Zoellick, B. W., T.P. O'Farrell, P.M. McCue, C.E. Harris, and T.T. Kato. 1987. Reproduction of the San Joaquin kit fox on Naval Petroleum Reserve #1, Elk Hills, California 1980-1985. U.S. Department of Energy Topical report EGG 10282-2144.